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Thread Blights.

BY

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WITH NINE PLATES.

The name Thread Blight is applied by the European planter in the Eastern Tropics to white mycelium which runs in well-defined, narrow strands, with the appearance of coarse, white thread, along the branches and over the leaves of plants at some height from the ground. It was first applied to white mycelium found on tea in Northern India, but the term has since been extended to similar white, or coloured, mycelia in Ceylon, Malaya, Java, Africa, and the West Indies.

As understood by the planter, a Thread Blight is a conspicuous white mycelium, which can be seen on the bush or tree from a distance of several yards. Repent mycelia which can be detected only on close examination are not Thread Blights to him. *Corticium Koleroga*, for example, which causes Black Rot of coffee in India, and the similar *Corticium* which causes Black Rot of coca in Ceylon (Plate II), are not Thread Blights, because the hyphae on the stem form a thin film which is practically invisible, when fresh, and the planter only sees the effect on the leaf. Pink disease (*Corticium salmonicolor* B. and Br.), again, is not a Thread Blight, because, although it may produce hyphae which run over the surface of the bark, these are diffuse and form almost a continuous sheet with broad, anastomosing, denser bands here and there. The distinction, however, is not a scientific one, nor does it hold good for any definite group of fungi. On Ceylon experience one would say that the Corticiums do not, in general, form Thread Blights, but three species from Java, viz., *Corticium Theae*, *Corticium Gardeniae* (?), and an unnamed species on tea, have a distinct barren cord running along the stem of the host plant.

The original Thread Blight, which occurs on tea in Northern India, was sent to Berkeley, and was noted by him in the Gardeners' Chronicle, No. 24, June 14, 1873, pp. 810, 811, as follows :—

"The Tea plantations in India have lately been much troubled with a parasite which has been named Thread Blight.....

It may, however, be described provisionally as *Corticium repens* B., hypothallo filiformi repente albo, hymenio pallide rufo. Spreading widely over living shrubs, on which it forms white, linear, creeping threads, which run off from the bark to the leaves; hymenium of a very pale rufous colour. At present it has not been observed apparently in its most perfect state, at least we have been unable to detach the spores so as to ascertain with certainty their form or nature."

Berkeley published another note on the subject in 1875, in which he stated that he had specimens on *Andrachne trifoliata*, as well as on tea. He gave a rough figure of the thread, and described it as "externally clothed with flexuous threads, in which, as far as we have ascertained, there are no joints." He did not make use of the name *Corticium repens* in this second note.

Unfortunately, Berkeley's specimen of *Corticium repens* does not appear to be included in his herbarium in Herb. Kew, and it is not possible to say definitely which species he had. There are at least two species of Thread Blight on tea in India, one of which is epiphytic and the other parasitic. As specimens were sent to Berkeley with the statement that the fungus was parasitic on tea, it might be assumed that he had the parasitic species, but, as will be evident later, that assumption may be incorrect.

The earlier literature relating to tea in India contains numerous references to Thread Blight, but most of them do not add anything to our knowledge of the fungus. Cunningham published a note on it in 1897, and stated that it occurred on tea in Darjeeling, and in the Andaman Islands. His description appears to be that of the parasitic North Indian Tea Thread Blight, but he did not describe any peculiarities in the threads, merely stating that they were "rhizomorphic aggregates of filaments."

In 1898, Massee described an Indian Thread Blight, said to be parasitic on tea, in a paper on Tea Blights. He gave no particulars of the external mycelium, except that the hyphae were 2-3 μ in diameter, vaguely branched, and sparsely septate. On a specimen submitted to him there occurred a small *Stilbum*, which Massee regarded as the fructification and named *Stilbum nanum*. This *Stilbum*, however, is a common saprophyte on dead twigs, and has no relation to the Thread Blight. Massee figured the *Stilbum* arising from expansions of the thread, but in the type of *Stilbum nanum* in Herb. Kew (Watt 11958), the *Stilbum* is on a twig which does not bear any Thread Blight. It is on a tea pruning which had been lying for some time on the ground. This *Stilbum* is red, not pale yellow as stated by Massee; and it is most probably identical with *Stilbella Heveae* Zimm. and *Stilbella Theae* Bernard. The account given by Massee of the penetration of the my-

celium into the wood may possibly refer to the mycelium of the *Stilbum*. His suggestion that Thread Blight is a root fungus, and spreads up the stem from the ground, is without foundation, but there is a root disease of tea, caused by *Polyporus interruptus*, in which the mycelium of the fungus may spread upwards over the stems of the bush, in a manner exactly similar to Thread Blight.

It is doubtful whether Massee had seen the Indian Thread Blight at the time he described *Stilbum nanum*. The type specimen of the latter contains one twig only, the one figured by him, and it does not bear any Thread Blight. Consequently it is not possible to state to which Thread Blight Massee intended to apply the name *Stilbum nanum* in 1898 The fact that he made no mention of any peculiar cells on the hyphae points to the epiphytic species, but on the other hand it is by no means clear that he examined the cord of Thread Blight. There are, however, in the cover of *Stilbum nanum* in Herb. Kew, specimens of Indian Thread Blight, collected in 1900, which were assigned by Massee to *Stilbum nanum*. These later specimens are the epiphytic species, and they are of great interest in that they bear a fructification, a *Marasmius*, which demonstrates that this species is identical with the common Thread Blight of Tea in Ceylon.

Consequently, as far as any evidence exists, the name *Stilbum nanum* was applied to the epiphytic species which had already been named from Ceylon, twenty-five years previously. Up to the end of 1920, there was no specimen of the parasitic Indian Thread Blight discoverable at Kew or the British Museum.

In 1904, Zimmermann described a Thread Blight which occurred on coffee in Java. From his description it was evidently similar to the parasitic Indian Tea Thread Blight. He gave it the name of " Spinnenwebezickte" from the appearance of the mycelium on the leaves. It is more or less characteristic of this class of Thread Blights that the thread divides, when it runs over a leaf, into a number of similar threads radiating from the leaf stalk, which become united laterally by thinner strands and separate hyphae into a continuous sheet.

Zimmermann stated that the thread was composed of parallel hyphae, with others which were more or less flexuose and furnished with numerous short lateral branches. He was unable to make any suggestion as to the function of these branches, but did not consider that they could serve to fasten the thread to the leaf, as they occurred in great numbers on hyphae which were not in contact with the leaf but extended freely into the air. He also found, between the hyphae of the thread, peculiar bodies which he named " anker " cells. These, in general, have long conical points at either end, and two or three similar points arranged in a circle round the middle ; they may be terminal

or intercalary. Zimmermann stated that he named them "anker" cells, because of their shape,—an explanation which leaves the precise meaning of "anker" somewhat in doubt.

In Ceylon, a Thread Blight on nutmeg was known in 1900, but was not recorded until 1905. Since then, the same Thread Blight has been found on tea, and other species on other plants. Photographs of the first-named species were published in the Tropical Agriculturist XXVI (April, 1906).

In the West Indies, a Thread Blight which occurs on Cacao was described by Lewton Brain in 1905. It had been found in St. Lucia and Trinidad. It occurred in dark brown strands, running irregularly up and down the twigs, and branching irregularly, but especially in the neighbourhood of a leaf or bud. When young the strands are white and thin, but they darken and become thicker later. Occasional swellings were found on the threads of the Trinidad specimen : these were at first taken to be reproductive bodies, but on examination were found to be merely masses of mycelium.

Lewton Brain stated that when the thread reached a bud, it spread out and branched, so that the bud became covered with a white felt. It also passed along the petiole, and branched and spread out along the main ribs on the lower surface of the leaf. Further development on the leaf was not observed. It killed the leaves fairly quickly. The strands were composed of closely-woven, but for the most part parallel, hyphae, the hyphae being narrow and septate. At first the hyphae were white and delicate, but as they became older, they became darker and their walls thickened, especially in the outer hyphae. On old branches, the hyphae did not penetrate into living tissue, but young green twigs, leaves, and buds were penetrated and killed.

Thread Blight of Cacao in the West Indies was again recorded by South in an addition to an article by Bancroft (1910). South suggested, from a comparison of the mycelia from different hosts, that in all probability the Thread Blights of the West Indies were due to different fungi in different localities, and he stated that clamp-connections had been found in some of the fungi on cacao.

In 1909, Stevens and Hall gave an account of a *Hypochnus* found on fruit trees in North America. This fungus formed strands which were at first white, but subsequently became glistening brown. The hyphae were more or less parallel, very uniform in diameter (5-8 μ), septate at intervals of 40 to 120 μ. Clamp-connections were not observed. On the thread, there occurred roundish or oblong sclerotia, usually 3-4 mm. diameter, white at first, becoming rich chestnut brown, composed of compactly-woven masses of swollen, irregular hyphae. Basidia were

found in the film on the leaves, and the fungus was identified as *Hypochnus ochroleucus* (Noack).

Burt subsequently transferred *Hypochnus ochroleucus* to *Corticium* and, the name *ochroleucum* being antedated in *Corticium*, renamed it *Corticium Stevensii*. It is of interest in connection with this account of the Thread Blights, in that Burt recorded as this species a specimen on *Codiaeum variegatum* sent by Rorer from Trinidad.

Bernard, in 1907, described a Thread Blight which was found on tea in Java. The threads occurred only on the younger branches and leaves, and were white, or pale rose. On the branches they were 0.5-2 mm. in diameter, sometimes spreading out into patches; on the leaf, they branched, forming at first a network somewhat resembling a cobweb, but ultimately covering the lower surface with a thin, pale rose film. The hyphae were 4-6 μ diameter, septate, branching dichotomously; Bernard figures them as equal, thin-walled, somewhat closely septate. Bernard was unable to find anything resembling Zimmermann's "anker" cells, but on the film on the leaf he found basidia in small groups. Consequently he described the fungus as a *Hypochnus, Hypochnus Theae.*

In 1910, Massee recorded a Thread Blight from the Gold Coast as *Marasmius scandens*. It occurred on Cacao. The pilei arose laterally from the thread, and were about 1 mm. diameter, sessile, white, striate above, with three to five gills. There is no type specimen of this species in Herb. Kew.

Bancroft, in 1911, recorded the occurrence of a Thread Blight on *Hevea brasiliensis*, *Cinnamomum Camphora*, and *Psidium Guyava* in the Federated Malay States. On the trees attacked, the young leaves withered and sometimes became matted in dense masses, while the younger twigs were killed. Bancroft described the thread as becoming thicker on the younger branches, and spreading out on the surface of the leaf until the whole of the under surface was covered with a white mass of fine fibrils. The description suggests a species similar to the parasitic Indian Thread Blight, but Bancroft did not describe any peculiarities in the thread. He stated that the hyphae were 4-5 μ diameter, septate at long intervals and sparingly branched; the branches arose at right angles to the parent hyphae, and then bent round parallel to them: clamp-connections occurred frequently in the mycelium on the leaves, but less often in the thread on the branch.

In 1914, Richards forwarded to Kew from Malaya, a specimen of Thread Blight on *Hevea*, which was described as *Cyphella Heveae* by Massee. There is, however, some element of doubt attached to this, as the type specimen of *Cyphella Heveae*, like that of *Stilbum nanum*,

does not bear any Thread Blight, and the fungus appears to be growing on palm tissue, not on *Hevea*.

In 1918, Butler published a full description of the Indian parasitic Thread Blight on tea, and so made it possible, for the first time, to differentiate between that species and other Thread Blights, and correlate it with the species described by Zimmermann in Java.

In the majority of cases, no fructification of the Thread Blight has been found, and hence it is impossible to classify them, or identify the species of one country with those of another. From the rare occurrence of clamp-connections on the hyphae, it is assumed that they belong so the *Basidiomycetae*, and that has proved to be correct in those cases in which the fructification has been discovered.

It appears, however, possible to separate the Corticiums by the shape of the hyphae, while the remainder may be divided into two main classes, characterised by the presence or absence of anker cells.

The following account deals with these Thread Blights chiefly from a morphological point of view, and indicates certain peculiarities of the cords which may assist in correlating the species of different countries. Field notes on the effects of the fungus on the plant have been included when possible, but it has not yet been practicable to undertake the full investigation of the action of the fungi on their several hosts.

A.—Corticium Thread Blights.

1. *Corticium* sp. on *Rubiaceae*, Sumatra.

(? *Hypochnus Gardeniae* Zimm.)

Dr. C. Bernard has kindly furnished me with specimens of a *Corticium*, on a Rubiaceous plant, from Sumatra, which has a superficial mycelium with the general appearance of a Thread Blight (Plate 1, fig. 2).

The thread is 0.3-0.5 mm. broad, white, slightly elevated in the dried specimens, but stouter and rounded in specimens preserved in formalin. It shrinks considerably and becomes flatter and thinner on drying. It is sparingly branched on the stem and runs somewhat flexuosely from node to node, but at the nodes it expands into a small sheet, or, more generally, forms a network encircling the node. Thus the length of the definite cord depends upon the distance between the nodes, and in the specimen photographed it is shorter than on stems on which the nodes are farther apart. The cord is not tough. It is bordered by a wide, thin membrane, 0.7 mm. broad.

The thread passes along the leaf stalk, and divides into very delicate strands, radiating fan-wise on the under side of the leaf from the base, and united by a thin sheet of hyphae which covers the whole under surface. In some cases the leaf is soon attacked. In other cases the leaf does not appear to be injured, and on such leaves the covering of hyphae appears powdery, owing to the presence of large numbers of basidia. It appears to be a general rule in these repent Corticiums in the East, whether Thread Blights or not, that the leaves which bear basidia abundantly are not injured by the fungus. Some basidia may be found on severely attacked and rotten leaves, but the patches which are densely covered with basidia occur, in general, on leaves which do not show signs of injury.

The lateral membrane contains a wide-meshed network of regular hyphae running parallel to the thread, or obliquely from it, sometimes with broad strands of thin-walled hyphae side by side, all united by a thin, hyaline, amorphous film. These hyphae (Plate IX, Fig. 1.) are regular, 6-10μ diameter, septate, with rare clamp connections. Some of them are quite normal, others have a strongly thickened wall. The walls of a hypha 6 μ diameter may be thickened until the lumen is only 1μ diameter. The septa, however, remain distinct and unthickened in these hyphae. Completely solid hyphae have not been observed in this species.

In addition to the larger hyphae, the lateral membrane contains fine hyphae, 0.5μ diameter, which bear hyaline globules, 1-1.5μ diameter.

The hyphae in the interior of the thread are 3-5μ diameter, regular, usually straight, thick-walled, but with the lumen and septa still evident. A few irregular bends occur, but they are rare in comparison with the usual Thread Blights. Sometimes adjacent hyphae anastomose. Anker cells and irregular inflations are absent.

The contents of the hyphae stain with eosin, but the walls and the hyaline film and globules do not. With cotton blue, the contents of the hyphae stain deeply, and the walls slightly.

The covering on the leaf contains a wide-meshed network of thin-walled, regular, septate hyphae up to 8μ diameter, united by a hyaline, amorphous film, and fine hyphae, 1 μ diameter, which bear hyaline, spore-like, globules laterally. From the regular hyphae there arise erect septate hyphae, 3 μ diameter, simple. often in groups, or branched, up to 50 μ high. The terminal cells of these hyphae are clavate, and are probably basidia, but no spores or sterigmata have been observed.

Large numbers of intrusive spores adhere to the thread.

As a Thread Blight, this differs from the more usual species in its regular, septate hyphae, and in the presence of thin septa after the

lateral walls of the hyphae have become thickened. It is probably identical with *Corticium* (*Hypochnus*) *Gardeniae* Zimm., found on *Gardenia florida* at Buitenzorg, the figure of which (Centralb. f. Bakt., Abt. 2, VII, p. 102) shows basidia in pairs at the apices of short, septate hyphae.

2. *Corticium Theae* Bernard.

I am indebted to Dr. Bernard for a specimen of this species on tea from Buitenzorg, Java.

The mycelium (Plate I, fig. 3) takes the form of a stout, rounded, continuous thread, running longitudinally along the stem, rarely branching and anastomosing. In the available specimens, it is about 0.3 mm., sometimes 0.4 mm. broad, tomentose, often with a broad membranous margin, and sometimes forming diffuse patches at the side of the cord. Bernard states that the cord may attain a breadth of 2 mm., and that the colour of the fresh specimens is pink.

The thread passes to a leaf along the under side of the petiole, and may divide into a number of strands radiating over the lower surface of the leaf, so fine that they are scarcely visible, or may form broad flat strands at the base of the leaf which divide up into finer strands after a distance of about a centimetre. Some of the leaves bear powdery patches; these, in general, do not bear any visible thread, except perhaps at the base of the leaf. According to Bernard, the patches on the leaf are a deeper pink than the cord on the stem when fresh.

The cord on the stem and the leaves is vegetative only. It is composed of regular hyphae, 3-6 μ diameter, of the same character as those of the *Corticium* on *Rubiaceae* already described (Plate IX, fig. 1). Knee bends occur sparingly, and some of the thin-walled hyphae bear short stumpy projecting branches, just below a septum, which are probably the traces of lateral branches.

The powdery patches on the leaves bear basidia on a foundation of interwoven hyphae which are similar to those of the cord. The basidia (*fide* Bernard) are ovoid, 20-25 x 6-8 μ, with four sterigmata 6-8 μ long, and ellipsoid spores, 7-9 x 5-7 μ.

This species is a true Thread Blight. Its cord is stouter than that of the species on *Rubiaceae*, and it apparently differs from the latter in the shape of its basidia.

In his first account of this species, Bernard instituted comparisons with Massee's *Stilbum nanum* and Zimmermann's "Spinnenwebeziekte", from the descriptions, and came to the conclusion that his species differed from these. In another publication in the same year he stated that Massee's Thread Blight was evidently the same as *Corticium Theae*,

basing his conclusion on the photograph of Thread Blight, published by Watt and Mann in The Pests and Blights of the Tea Plant, 2nd Ed., Plate XX, fig. 3. The resemblance, however, is merely superficial.

Species of *Corticium* with aerial mycelium occur in Ceylon on tea, *Erythroxylon Coca*, and *Oxyanthus tubiflorus*. These have been referred to *Corticium Theae*, but a glance at the Java specimen shows that the reference is incorrect. The Ceylon species do not form a visible thread. They form a delicate film of hyphae along the stem and over the leaves, quickly rotting the latter and binding them to one another and to the stem. The effect is similar to that of *Corticium Koleroga* in India, and, like the latter, the disease caused by them is known as Black Rot. Sometimes a very fine brown fibrillose strand can be detected under a low magnification, but there is no clearly visible thread as in the Thread Blights. The hyphae, too, are not thick-walled or solid.

The basidia of these latter species are usually borne on powdery white patches on leaves which do not exhibit signs of injury. On coca, however, the mycelium on the stem may bear basidia and the fungus is then evident to the naked eye as a broad white streak along the stem, sometimes extending over two-thirds of the circumference. But even in that case, the visible white area is too broad and diffuse to be regarded as a thread. The Ceylon species of *Corticium* which have aerial mycelium are not, as far as is known, Thread Blights.

3. *Corticium* sp. on Tea, Sumatra.

Dr. C. Bernard has also sent me another Thread Blight on tea from Sumatra, which is probably a *Corticium* (Plate I, fig. 1).

The thread is white, about 0.2 mm broad, generally flat and not very conspicuous, expanding here and there into a thin sheet, or dividing up into hyphae and disappearing macroscopically. The hyphae of the thread are regular, 4-8 μ diameter, thick-walled, septate, with some solid hyphae in the older parts of the thread. Clamp connections have not been observed. With eosin or cotton blue, the contents of the hypha stain, but the wall does not.

At intervals along the thread there occur irregularly pulvinate, yellowish-white cushions, up to 6 mm. diameter. These may be situated at irregular intervals, or confluent in masses up to 2.5 cm. long ; they may occur at the old leaf scars, or at a fork ; but they are not confined to those positions, and the majority in the available specimens have no relation to any definite structural feature of the stem. These cushions are not sclerotioid, but soft and spongy, with a glabrous, wrinkled, outer coat of interwoven hyphae. The hyphae in the interior are loosely inter-

woven, regular, 3-5 μ diameter, with distinct septa, of the same character and the same reactions to stains as those of the thread.

The thread passes from the stem *via* the petiole to the lower surface of a leaf, and breaks up into hyphae which either cover the leaf with a thin film and kill it, or else give rise to basidia in white patches. The leaves which bear basidia do not exhibit signs of injury. The white patches are usually broken up, not continuous, but it is possible that they may ultimately coalesce. Similar patches are formed on the stem. Mature basidia have not been found. The structures which are taken to be immature basidia occur on short, erect, septate hyphae, both laterally and terminally, and are narrow-oval or clavate, 9 x 4 μ.

This species apparently differs from *Corticium Stevensii* in that the thread is white, not brown, and the cushions are not sclerotia composed of compact irregular hyphae, but merely spongy masses of regular hyphae.

In De Thee, vol. IV, p. 86 (1923), R. Menzel has recorded the occurrence of the larvae of a Cecidomyid in these cushions. This raises the question whether the cushions are a normal part of the fungus or galls caused by the insect.

B.—Marasmioid Thread Blights With Anker Cells

(1) The Indian Tea Thread Blight.

Specimens of this Thread Blight have been kindly furnished by Mr. A. C. Tunstall, the Mycologist of the Indian Tea Association, and I have others collected below Darjeeling in 1900.

The cords on the stem are white, flattened or rounded, up to 0.5 mm. broad, often expanding into broader patches at the persistent bases of dead leaves. In some specimens the cords are tomentose, or slightly woolly, on the exterior, though firm and compact within. Butler describes the cords as firm and smooth on the surface, but becoming fluffy and of a consistency resembling cotton wool. It would appear that, as in other species, the character of the surface of the cord varies with its age, or with weather conditions. The cords on the stem often branch and re-unite, forming a network. On the thinner twigs, the cords tend to become stouter, a feature which appears to be peculiar to this class of Thread Blight. When old, the cord acquires a brownish tint.

From the stem the cord passes to the under side of the leaf along the petiole. At the base of the leaf blade it usually divides into a large number of finer cords which spread out fanwise over the leaf surface. These cords are united laterally by a network of hyphae, so that the under surface of the leaf is covered with a thin, white sheet. In some

instances, the only cord evident macroscopically, runs along the mid-rib, the remainder of the leaf surface appearing covered with a white sheet only, but in such cases, a microscopic examination usually reveals narrow, white cords, about 0.2 mm. diameter, radiating from the base of the leaf. The sheet of fungus tissue on the leaf is minutely tomentose, or may appear silvery when very thin. Where leaves or twigs are in contact, the mycelium passes from one to the other and binds them together. Butler records that, in great humidity, it may cross spaces up to half an inch.

A longitudinal section of the cord on the stem shows that it is composed, for the greater part, of hyphae which run parallel to the stem, but more or less flexuosely. The outer edge usually bears a few free spreading hyphae.

The main hyphae of the cord (Plate IX, fig. 2) are about 3 μ diameter, straight, or here and there closely flexuose. They are either thick-walled or solid, with all possible transitions between the two. In many cases, the lumen is reduced to a narrow cavity which is discontinuous, or the lumen may only be present for a short length where the hypha is swollen to a greater diameter. Swellings and abrupt bends, however, are rarer in the available specimens of this species than in other Thread Blights. Branches arise at an acute angle from the parent hyphae, and usually soon take a position parallel to the latter, though in a few instances they run diagonally across the thread. Sometimes the branch is thick-walled and the parent hypha solid. The branch arises just below a septum, but this is not evident where the parent hypha has become solid. When the thread is teased out, lateral angular swellings may be found on some hyphae, which represent the points of attachment of branches. Branching, however, does not appear to be common in these hyphae. Similarly, long lengths of thick-walled hyphae, up to a millimetre long, may be traced, which show no signs of septa. Clamp connections have not been observed in these thick-walled hyphae. It would appear that the septa are absorbed, and that the clamp connections are represented by swellings on the thickened walls. Short, irregular, jointed lengths sometimes occur in the solid hyphae.

At the base of the cord, the hyphae are parallel and thin-walled, with evident septa. The basal layer consists of a continuous sheet of thin-walled hyphae, fused together laterally, while in the middle of the cord the same hyphae occur to a height of about 30 μ. These thin-walled hyphae may attain a diameter of 7 μ, varying from 3 μ to 7 μ. The tissue formed by them appears looser and whiter than the remainder of the cord.

At the exterior of the cord, many of the hyphae are 1.5-2 μ diameter, thin-walled, and septate, with clamp connections. These arise as lateral

branches from the thick-walled hyphae, and their mode of branching is the same as that of the latter. Many of these thin-walled hyphae, however, bear short lateral outgrowths up to 6 μ long, equal, or slightly inflated at the tips, or sometimes conoid, perpendicular to the parent hyphae (Plate IX, fig. 4.). These out-growths are usually simple, sometimes forked, and may be scattered, or arise close together in clusters ; they are generally rough with minute, hyaline, refringent granules. as are also the hyphae from which they arise.

Some of the thin-walled hyphae at the exterior of the thread terminate in the peculiar cells which were named " anker " cells (Plate IX, fig. 3.) by Zimmermann. These, however, are rare on the cord on the stem in the available specimens of this Indian species, but are common in the film on the leaf. On the stem, they may be thin-walled, or have only slightly thickened walls, and spherical, 8-16 μ in diameter, without any apical or lateral projections. Generally they are spherical or oval, with solid apical and basal processes, and measure 12-24 x 8-10 μ. A few have a single lateral process, while others have two processes towards the apex. In the film on the leaf, the same shapes occur, together with larger, fusoid cells, up to 50 μ long and 12 μ broad, with long, solid, obtuse apical and basal processes and one or two lateral processes. Three processes, in addition to the apical and basal processes, have been observed, but these have been irregularly situated, not in a median circle. In general, the anker cells on the leaf are more strongly thickened than those on the stem.

It is probable that the spores referred to by Berkeley in his account of *Corticium repens* were the anker cells.

In addition to the forms of hyphae already described, very slender hyphae, 0.5-1 μ diameter, run among the outer hyphae of the cord. These may be free for short distances, but are frequently closely adherent to the thick-walled hyphae and over-run them irregularly. They are usually irregularly and closely wavy, and bear short lateral branches of a similar character (Plate IX, fig. 5.). They are often encrusted, or beaded, with minute, hyaline, globose granules. These fine hyphae occur in greatest number at the sides of the cord, spreading out over the bark ; and in some cases they are united into hyaline, membranous patches.

A few of the hyphae, both thin-walled and solid, bear free, clavate, or nodular, processes, about 12 μ long and 2 μ diameter, studded with minute, sessile granules, or bristling with minute points which sometimes bear granules (Plate IX, fig. 6.)

All the hyphae at the exterior of the thread tend to be more or less encrusted with hyaline granules, but these are especially numerous on the hyphae which bear the short lateral outgrowths and on the very slender

hyphae. The greater number of them are situated laterally on the hypha, but in many instances they are terminal on the short branches and then resemble spores. Their nature has not been ascertained; on staining with eosin, they appear to take the stain, but the colour washes out immediately with water; they dissolve in concentrated hydrochloric acid without effervescence, and appear to diminish in size when the hyphae are mounted in glycerine. It seems probable that they consist of some substance which serves to bind together the outer hyphae of the cord, and to fasten it to the host plant.

With cotton blue, the thick-walled hyphae stain, but the solid hyphae are hardly coloured. With eosin, the walls of the hyphae do not stain, but the cell contents do; consequently the solid hyphae remain colourless, while those with thickened walls show thin, coloured, central lines, often interrupted where the hypha has become completely solid. With methyl violet after tannic acid, all the elements stain deeply.

In the film on the leaf, the hyphae in the cords are thin-walled, septate, and about 2 μ diameter in the available specimens. From a comparison with other species it is probable that some of these may become thick-walled later. Between the cords, the film is a network of thin-walled hyphae, 2 μ diameter, with numerous, short side branches, mingled with the fine branched hyphae, 0. 5-1 μ diameter, which are encrusted with hyaline globules. Anker cells are abundant.

The effect of this Thread Blight on tea is described by Butler as follows :—

"The effect on the leaves is that browning and death of the leaf cells sets in, some time after the film spreads out on the under surface. This effect, is, for a time, sharply limited to the part covered by the fungus, but, especially when the attack begins from the base, the rest of the leaf soon withers and it falls off.....No trace of penetration of the epidermis has been detected, and the fungus can be lifted off when wet without breaking it. It seems probable that the peculiarly branched inner layer.....forms a sort of hold-fast or appressorial layer, though the cuticle does not seem to be indented or marked by its branches. On the petiole and green part of the stem, the strands are composed of hyphae similar to those of the outer layer on the leaf.....and entirely superficial. Lower down, however, the fungus enters the tissue of the stem....Branches pass down through the cork layer, which....is not continuous when first formed, and accumulate in the cortex below the young cork. The result is the gradual destruction of all the tissues external to the hyphae....The hyphae have been traced as far in as the cambium".

(2) The Cobweb fungus of Java.

The following details are taken from Zimmermann's account of this fungus.

The mycelium occurs on the branches as a thick, pure white cord, which can easily be seen with the naked eye. From the branches, the cord travels to the under side of the leaves, and spreads out gradually in very fine threads over the whole surface. The film formed by these fine threads may be likened to a cobweb.

The leaves attacked soon lose their green colour, gradually become more or less dark brown, and die. If affected leaves come in contact with sound leaves, the fungus can pass over to the latter, and in that way, and by the growth of the cord along the branch, a large number of leaves can be killed. In consequence, branches of considerable thickness may die.

The cobweb fungus occurs on coffee throughout Java, but it is not common. It appears to occur in localities which are exceptionally damp, or where the shade is dense because of the thick growth of the coffee.

The cords on the stem, and the films on the leaves, consist of very fine hyaline hyphae, which run parallel to one another in the former, but on the leaves are united in an irregular network. In preparations of the film of the leaf, it is seen that the hyphae are not all of the same kind. Some are cylindric, and straight for great distances, while others are more or less flexuose, and bear very numerous, short, side branches. These short side branches are especially numerous on hyphae which are not in contact with the leaf, but project freely into the air (Plate IX, fig. 7, after Zimmermann).

In addition, there occur on the leaf and the stem, between the hyphae, and united to them, peculiar bodies, which, when they are fully developed, are furnished with several processes of a homogeneous nature and a central cavity with granular contents (Plate IX, fig. 8, after Zimmermann). Two of the processes are especially long, the basal one, which is united to a hypha, and the apical one, which ends in an obtuse tip. Besides these two, there are generally three other smaller processes situated mid-way between the other two. These bodies may be termed anker cells, because of their shape. On following the development of the anker cells, it is seen that they originate as an elongated cell, inflated in the middle, which produces the median projecting processes later.

A specimen of a Thread Blight with anker cells (Plate IV, fig. 1) has been forwarded to me by Dr. C. Bernard from Sumatra where it

occurred on tea. It is on a rather thick stem, with one lateral twig, and is a comparatively young development. The cord branches and forms a network on the main stem, and runs up the lateral twig, but it does not become thicker on the latter, probably because of its age. It spreads out on the underside of the leaves and forms a continuous film.

The hyphae of the thread are similar to those in the corresponding Indian and Ceylon forms. Septate hyphae were not found at the base of the thread, and the "toothed" hyphae figured by Zimmermann are rare. Many of the anker cells are thin-walled, again probably owing to immaturity; some are fusoid or ovoid, 16-32 x 10-6 μ, as shown by Zimmermann, but the majority are globose, about 12 μ diameter, as in the Indian and Ceylon collections. Some of the globose anker cells lack a terminal point, and lateral points are rare.

The specimen appears to be identical with the corresponding Indian and Ceylon forms.

(3) Form on *Gymnosporia emarginata* and *Strobilanthes* sp., Ceylon.

A Thread Blight of the same type as the Indian parasitic species on tea occurs on a bush of *Gymnosporia emarginata* in the Botanic Garden, Henaratgoda, Ceylon, where it has been under observation for some years.

Gymnosporia emarginata Hk. f. (*Celastraceae*) is properly an inhabitant of the dry zone of Ceylon, and has pronounced xerophytic characters. It is a scrambling shrub, with long, rigid branches which bear short horizontal spinous twigs. The plant at Henaratgoda is growing in the open, and forms a loose mass, about eight feet high, of long decurving stems. The leaves and flowers are borne in clusters, at distances of one half to one inch, on short lateral shoots not exceeding one-eight of an inch in height, scattered along the stems, or at the base of the spinous twigs, or on the twigs. Usually there are two leaves in each cluster.

The Thread Blight (Plate III) runs along the branches, generally on the under surface. It is white, somewhat flattened, minutely tomentose, up to a millimetre wide, sometimes with a broad membranous border, sometimes expanding into a sheet, which, in rare cases, almost surrounds the stem. The cord is usually thicker on the smaller branches. It is seldom branched, but occasionally it divides and the branches re-unite and form a network. It often follows a somewhat zigzag course from the base of one lateral shoot to the next. When the cord meets a lateral shoot it forms a dense weft, or cushion, of mycelium round its base, and sends out a branch which travels up the leaf stalk and spreads out in a thin film on the under surface of the leaf. Sometimes fine cords

can be detected in this film, radiating from the base of the leaf : in other cases the film is uniformly thin. When old, the cord on the stem becomes brownish.

As a result of the attack of this fungus, one finds long lengths of the branches on which all the leaves are dead and brown. Beyond these, however, on the parts which have not yet been reached by the fungus, the leaves are green and healthy. The leaves remain for some time hanging from the branch, fastened to it by the mycelium. The thick branches do not appear to be damaged by the fungus, but when it grows over small branches these latter are killed. The part of the lower side of the leaf which is covered by the film becomes greyish or blackish, while the corresponding upper surface becomes yellowish green, mottled with brown, with a watery green margin. In this stage,the whole of the film can readily be detached from the leaf when fresh. The change in the colour of the leaf appears to be late in developing, perhaps because of the coriaceous nature of the leaf in this species. Finally, the whole leaf dies and turns brown.

The change in the colour of the leaf is best seen in wet weather. In dry weather, a leaf may be almost completely covered by the fungus without exhibiting any sign of injury.

In addition to the foregoing mode, the leaves may be killed by the attack of the fungus on the leaf stalk, or on the short shoot, without the occurrence of any film on the leaf blade. The short shoot, as already stated, is covered by a weft or cushion of mycelium, and this mycelium attacks the leaf stalk, etc. The leaf stalk turns brown first, and this is quickly followed by the browning of the whole blade. The two leaves of a shoot do not, as a rule, die at the same time.

The thread is very compact, and yellowish internally. Its main hyphae are 3-4 μ in diameter, thick-walled or solid, and do not differ from those of the parasitic Indian tea Thread Blight. Hyphae 2 μ in diameter, with thin walls, occur on the exterior of the thread and in the membranous film which spreads from its base over the branch. Toothed hyphae, i.e. hyphae with short lateral branches, such as occur in the corresponding Indian form, are rare. The ultimate fine branches, 1-0.5 μ diameter, are usually long and straight, but sometimes bear a whorl of branches arising from a common point. These fine hyphae arise from the thick-walled hyphae, and are occasionally grouped in tufts. Club-shaped processes, either simple or lobed, up to 12 μ high and 3 μ diameter, are also present. The fine hyphae, and the thick-walled hyphae towards the exterior of the thread, are beaded with hyaline granules, and there is a well-developed amorphous layer on the exterior of the thread. In addition, the thread, and the film on the leaf

are in this form strongly encrusted with amorphous masses of calcium oxalate.

Anker cells (Plate IX, fig. 9) are present in large numbers on the exterior of the thread, but become rarer within it. In general they are spherical, more rarely oval, with an apical and a basal projection only. Spherical anker cells which lack an apical point are not uncommon. The majority are small, do not exceed a total length of 12-16 μ, and are comparatively thin-walled. Spherical anker cells, however, may be found up to 24 μ in diameter, and elongated fusoid cells up to 35 x 7 μ. In rare cases a single lateral point is present.

At the base of the thread, the tissue is whiter and appears looser than that above it. This basal layer forms a continuous white sheet or is split into anastomosing bands. The hyphae of which it is composed are more regularly longitudinal and parallel than those in the main body of the thread, and are united by an amorphous film in which numerous granules are embedded. These hyphae are thin-walled and up to 10 μ in diameter. Septa are present, but clamp connections have not been observed. Many of the septa are perforated, and wholly or partly absorbed (Plate IX, fig. 10). Lateral branches of a hypha 10 μ diameter may be only 3 μ diameter.

A recently-developed film on the leaf, in places where no cord is evident, is based on a foundation of thin-walled hyphae up to 7 μ diameter which form a wide-meshed network over the surface. These are united by a continuous amorphous film in which are embedded fine beaded hyphae, 1-0.5 μ diameter, and a few solid hyphae, 2 μ diameter, studded with granules. Anker cells are rare in the youngest stages, but become abundant later. They are hyaline, with granular contents, at first, but subsequently become brown and homogeneous. The structure of the thread on the leaf is the same as on the stem.

The tissues of the dead leaf are permeated by hyphae which vary from 1 to 4 μ in diameter. The larger hyphae pass through the stomata, but the finer, 1 μ, hyphae appear to penetrate the epidermis at any point. It has not, however, been determined at what stage of the attack penetration takes place.

On the older stems, the finer hyphae penetrate through the cortex into the wood, but there is no external evidence of injury. On the younger stems the tissues are browned and the stem ultimately killed; as far as has been determined, it appears that in such cases only the finer hyphae are present in the tissues in the earlier stages.

Another collection, apparently of the same species as that on *Gymnosporia*, was made in one of the wettest districts in Ceylon, where it was found growing on a species of *Strobilanthes*

The cord on *Strobilanthes* branches freely on the thicker parts of the stem, the branches anastomosing and forming a network; the marginal film frequently spreads out into a broad patch which may completely cover the area enclosed in the meshes of the network. The cord is white and minutely tomentose, but when rubbed the surface appears brown, and the brown discolouration extends to a small depth within the cord. The discolouration is due to the presence of brown amorphous masses, anker cells, and algae which have been included in the outer layers. The same colour is evident on a worn specimen of the parasitic Indian tea Thread Blight, and on the older parts of the thread on *Gymnosporia*; it is more marked in this specimen on *Strobilanthes*, but the latter appears to be an old specimen. The threads of the cord, even those on the exterior, are nearly all almost solid, and the finer hyphae are difficult to find. The amount of debris attached to the exterior of the cord may also be taken as evidence of age.

Any spores which happen to fall on the cord of a Thread Blight are liable to become attached. On tea, *Pestalozzia* spores are frequently found adhering to the thread. In the form on *Strobilanthes*, there is a large number of spherical, echinulate, greenish-hyaline spores, 3-4 μ diameter, resembling the spores of a *Sterigmatocystis*, which appear to be intrusive.

The cord passes along the leaf stalk and spreads out in a thin film on the lower side of the leaf. In one instance, a leaf 16 cm. long and 9 cm. broad was completely covered, except for the apical 2 cm., by a thin, white film which to the naked eye appeared uniform, but which when examined under a lense showed fine underlying threads, radiating fanwise from the leaf stalk. Other leaves show similar patches of less extent, but all advancing uniformly over the leaf from the leaf stalk.

In another instance, the mycelium had spread from a dead stem to a leaf, attacking the latter at the margin about the middle of its length. The mycelium bound the edge of the leaf to the stem, and then spread out over the lower surface fanwise in repeatedly-dividing strands which extend over an area 8 cm. long and 12 cm. broad. From these strands, the continuous covering was just beginning to develop at the time of collection, and it can be detected as a glistening film when the dried specimen is viewed obliquely.

Attention was drawn to this plant of *Strobilanthes* by its blackened leaves. The upper surface of a leaf had turned black over an area which corresponded exactly with the extent of the fungus film on the under surface. In general, the blackened patch was continuous, but in the case of the leaf noted in the foregoing paragraph, a system of branching black lines radiated from the point of attachment, in correspondence with the

strands on the lower surface. The effect of the fungus on the thin leaf of the *Strobilanthes* was greater, and apparently more immediate, than on the xerophytic *Gymnosporia* leaf.

The structure of the thread in this form is identical with that of the thread on *Gymnosporia*. The anker cells are the same shape and size, toothed hyphae are rare, and the fine ultimate hyphae, though scanty on the old thread, are also the same.

Judging from Zimmermann's figures, the anker cells of the Java form differ from those of the other two. In the Ceylon and Indian forms, the anker cells are most frequently spherical or ovoid, especially in the cord on the stem. It may, however, have happened that Zimmermann drew his figures only from the film on the leaf; and, in that situation, they can be matched by anker cells on the leaf in the Indian and Ceylon forms. In a recent specimen from Sumatra, which is probably identical with Zimmermann's species, the anker cells are chiefly spherical. It would appear most probable that these Thread Blights which possess anker cells are identical. In no case is the fructification known, but the mycelium agrees in general structure with that of the Thread Blights which have been found to belong to species of *Marasmius*.

C. Marasmioid species without anker cells.

(1) *Marasmius pulcher* (B. & Br.) Petch.

This is the common Thread Blight of tea in Ceylon, where it has also been found on nutmeg, *Beloperone oblongata*, *Garcinia ferrea*, etc. It occurs on tea in India, and, as far as the specimens can be relied on, it is the species to which Massee gave the name *Stilbum nanum*.

The cord is white, minutely tomentose, becoming glabrous and slightly brownish when old. It is usually about 0.5 mm. diameter, with a narrow border closely adherent to the host plant. As a rule, it runs longitudinally along the lower side of a twig, giving off lateral branches which usually do not proceed far before terminating in a pencil of hyphae. It does not become stouter as it ascends the stem or twig, and, in general, it does not form a network on the stem (Plate IV, fig. 3).

When infection occurs on a thick tea branch in a wound where the wood is decaying, the growth of the mycelium is more vigorous, and cords may spread in all directions from the wound, branching repeatedly.

From the stem, the cord proceeds along the leaf-stalk to the lower surface of the leaf. It may form a network on the leaf-stalk. On the lower surface of the leaf it may divide into several branches radiating from the base, or it may run over the leaf as a single cord, often near

the margin. But even in cases where it has divided into numerous branches it does not, as a rule, form a continuous film on the living leaf (Plate IV, figs. 1, 2.). This has been the case in the numerous specimens examined, but it is possible that it might form a continuous film under conditions of greater humidity. The cord passes from one leaf to another, or from a stem to a leaf, if the two are in contact, but it has not been observed to bridge any gap (Plate V. fig. 4).

The main hyphae of the cord are similar to those of the Thread Blights which possess anker cells, but abrupt knee bends occur more frequently. The hyphae are for the most part 2-3 μ diameter, thick-walled or solid. Some attain a diameter of 5 μ. Septa are rare in the thick-walled hyphae, and clamp connections have not been observed. Some of the solid hyphae separate into lengths with swollen or irregularly nodular ends (Plate IX, fig. 12). The hyphae usually stain with eosin, and strongly with cotton blue.

At the base of the cord, some hyphae are thin-walled, 2-5 μ diameter, with evident septa, but these do not form such a distinct tissue as the similar hyphae in the Thread Blights which possess anker cells.

The thin film which borders the cord contains a network of thick-walled hyphae about 2 μ diameter, from which arise large numbers of very fine branches, apparently solid threads, about 0. 5 μ diameter. Some of these branches remain short and simple, but most of them give off secondary branches, singly or in whorls, and these secondary branches may repeat the process, so that a dendroid structure resembling a conidiophore is produced (Plate IX, Fig. 14). The main trunk of this dendroid structure is usually thickened in a fusoid shape at the points where its branches arise. In some instances, the primary fine hypha becomes thickened clavately above and numerous branches radiate from this clavate head. In other cases, simple fine hyphae arise in tufts directly from the thick-walled 2μ hyphae. The dendroid structures may attain a total length of 20 μ.

The same dendroid hyphae arise from the superficial hyphae of the thread. In some instances they bear hyaline globules at the ends of the branches, thereby increasing the resemblance to a conidiophore. Hyaline globules, however, appear to be less common in this species than in the Thread Blights which possess anker cells. In some specimens, they are almost absent ; in others, they occur on the thick-walled hyphae at the exterior of the thread. As in other species, the cord becomes covered with a hyaline film, and the narrow border has a basal film of the same character. This appears to be formed in this species chiefly by the fine dendroid hyphae. Toothed hyphae have not been observed in this species.

When a leaf which bears this Thread Blight dies, and remains hanging from the twig, attached by the cord, the fungus grows out as a very thin powdery film over the whole of the lower surface. This film consists of a few hyphae, 1.5-2 μ diameter, with walls thickened or not, sometimes bearing innumerable dendroid hyphae, sometimes merely spinulose. Numerous short free clavate branches are present, up to 8 μ long, and these may be either spinulose or bear short fine threads.

These powdery films produce large numbers of shallow pezizoid bodies, up to 0.5 mm. diameter, often closely crowded together and covering nearly the whole film (Plate VIII, fig. 1). They are cream-coloured or yellowish internally, with a white pruinose margin. They contain 4-spored basidia, with cymbiform, hyaline spores, 6-8 x 4 μ.

The same fructification has been found on expansions of the Thread Blight cord on thick tea stems, especially in cases where the cord arose from a wound containing decaying wood. It has also been found on stems of *Beloperone oblongata*, on expansions of the cord and on the cord itself; and it has been developed on tangles of leaves and stems bearing Thread Blight, which have been left to decay on soil under a bell glass.

This fructification was sent to Berkeley and Broome by Thwaites, and was described by them as *Cyphella pulchra* B. & Br., Fungi of Ceylon, No. 665. In the co-type in Herb. Peradeniya, the *Cyphella* cups are seated on a film of the structure described above, and one piece has part of the cord attached.

When the supposed *Cyphella* is examined under a microscope, however, it is seen that many of the cups are incised on one side, and in some cases one or more ribs radiate across the cup from the incision (Plate IV, fig. 3). This gave occasion for doubting whether the fungus was really a *Cyphella*, and on keeping a tangle of Thread Blight as described above, a sessile *Marasmius* was obtained. This has since been found on leaves of tea, covered with Thread Blight, which had fallen into the middle of a tea bush and decayed there. *Cyphella pulchra* is, therefore, an imperfect development of a *Marasmius*, which must be known as *Marasmius pulcher* (B. & Br.) Petch.

An extensive development of *Marasmius pulcher* has also been found on dead leaves and twigs in a tangle formed by Thread Blight on *Garcinia ferrea*. In this case, the thin powdery film and the expansions of the thread were not present. The pilei arose either from the thread, or from parts of the dead leaves or twigs on which no mycelium was evident externally. It is clear, therefore, that the cord gives rise to hyphae which penetrate dead material as a normal mycelium.

Marasmius pulcher, in the specimens hitherto seen, is sessile, resupinate or laterally attached, or shortly stalked, reniform or orbicular, up to 3 mm. diameter, white, convex, sulcate over the gills, minutely pruinose, lower surface and gills white or ochraceous. Gills few, one to four extending from the point of attachment to the margin, with three or four shorter ones. Spores white, cymbiform, 6-8 x 4 μ.

In Herb. Kew, there are specimens of this Thread Blight on tea from India, collected in 1900 (No. 14346), which were sent from the Calcutta Herbarium and were included by Massee in the cover of *Stilbum nanum*. One of these includes the fructification on decaying leaves, both in its apparent *Cyphella* and its fully developed *Marasmius* form.

This species has been under observation for some years on nutmeg in the Royal Botanic Gardens, Peradeniya. It does not appear to kill the twigs or the leaves, nor to cause the latter to fall prematurely.

On October 1st. 1918, all dead leaves were removed from an affected branch, and a diagram made showing the remaining leaves and the distribution of the cords. On December 16th, one leaf which bore Thread Blight became detached, but remained suspended from the twig by the cord ; it was the oldest leaf on that twig. On another twig on the same date the oldest leaf, which did not bear any Thread Blight, was turning yellow, and this fell a few days later. On December 30th, the oldest leaf on a third twig was turning yellow and fell when touched : this leaf did not bear Thread Blight.

No more leaves fell up to March 9th, 1919. The oldest leaves on two twigs were then turning yellow ; both these leaves bore Thread Blight, and after becoming detached a day or two later, remained suspended from the twigs. At this time there was a general fall of the oldest leaves from this tree. On March 27th, the oldest leaf on another twig which bore Thread Blight was turning yellow. At this date there was a general fall of the oldest leaves all over the nutmeg grove, after six weeks' drought followed by one week's rain.

When the leaves which bear this Thread Blight die, the changes in the colour of the leaf are exactly the same as on the unaffected leaves which are thrown off normally. In both cases, the yellowing of the leaf begins from the leaf stalk. Again, in all the cases noted above in which a leaf which bore Thread Blight died, it was the oldest leaf on the twig, and it died at the same period as other oldest leaves which did not bear Thread Blight. Hence it appears that this Thread Blight is not parasitic.

In general, the nutmeg or tea leaf does not show any signs of injury in the neighbourhood of the cord. When the cord runs over a stoma

on a nutmeg leaf, the depression in which the stroma is situated is filled by a plexus of mycelium, but the hyphae do not enter the stoma.

On the tea stem, the bark of which is usually irregularly longitudinally cracked, the hyphae of the cord run in the cracks, and give off fine branches, about 1μ diameter, which penetrate between and into the dead outer cells. These fine branches may be beaded with hyaline granules, and they may be dendritically branched. They have not been observed to penetrate below the tabular cork layers.

A species of Thread Blight, similar in structure to the thread of *Marasmius pulcher*, has been observed on a cacao stem from the Gold Coast. The thread runs irregularly along the stem, and is white, thin, pruinose, 0.1. mm. broad, with a thin pruinose border, up to 0.2 mm. wide, which in places expands into pruinose patches. The hyphae are hyaline, flexuose, thick-walled or solid, 2-2. 5 μ diameter. The exterior hyphae and those in the marginal film bear clavate branches, up to 12 μ high, 2 μ diameter, densely covered with radiating fine hyphae, 0.5 μ diameter and up to 10 μ long, or the same fine hyphae arise in tufts from the 2 μ hyphae. No fructification occurred with this thread,

It may be noted that the mycelium of *Hirneola polytricha* often spreads over the thicker stems of the tea bush in white, branching strands which resemble a Thread Blight. These are distinguished from the Thread Blights by the form of the hyphae.

(2) *Marasmius scandens* Massee.

A white Thread Blight which occurs on cacao, kola, etc., in West Africa was described by Massee under the name *Marasmius scandens* from specimens sent by Mr. W. S. D. Tudhope from the Gold Coast. Subsequently Mr. Tudhope kindly forwarded sterile specimens of what is believed to be the same Thread Blight on cacao, and I am indebted to Mr. R. H. Bunting for an extensive collection of both fertile and sterile specimens on cacao and kola. Massee did not describe the structure of the thread, and there is no type specimen in the Kew Herbarium.

In one specimen, on a cacao branch, 2-3 cm. in diameter, (Plate VI, fig. 1.) the white cords are stout, up to 1 mm. broad and 0.4 mm. thick, compact, prominent, rounded above, and, in general, lacking a membranous margin. They branch freely, and the branches anastomose to form a network. In one place, several main cords run more or less parallel to one another, united by numerous branches. On thinner stems, the cords are not so stout, and are frequently furnished with a membranous border, but there is the same tendency to form numerous cords on one stem. The thread is at first tomentose, becoming glabrous

and brown when old. But the old brown cords are white internally.

The thread travels to the leaf *via* the leaf stalk, and is usually confined to the under surface. Towards the base of the leaf, the thread is about 0. 3 mm. broad, diminishing as it travels towards the apex and divides into numerous branches which finally terminate in pencils of hyphae. Sometimes it forms more or less circular, felted patches of hyphae, up to 5 mm. diameter, near the base of the leaf, and similar patches occur where two leaves are united by the mycelium. On one leaf, thin powdery patches, covering an area 2-3 cm. long and broad, and superficially resembling the fruiting patches of a *Corticium*, were observed.

The hyphae of the thread are 2-3 μ in diameter, thick-walled or solid, flexuose, of the usual Thread Blight type. They stain with eosin. In the specimen on the thick cacao branch, oval hollow inflations are frequent on the solid hyphae, and some hyphae, 2 μ diameter, exhibit lengths up to 100 μ long over which they are irregularly swollen to a diameter of 4 μ (Plate IX, fig. 15), but neither of these appears to be of general occurrence. The outer hyphae may bear numerous very fine, solid, tapering hyphae, 0. 5 μ diameter and up to 60 μ long, simple or branched.

Septate, thin-walled hyphae, up to 5 μ diameter, occur sparingly in the interior of the cord towards the base, and rather commonly in the basal layer. Clamp connections are present on these hyphae. Branched hyphae, with perfect lateral branches, are also found towards the base of the cord.

The hyphae at the exterior of the thread are verrucose with minute hyaline globules, and the same globules occur on the very fine tapering hyphae. Here and there the thread is overlaid by a hyaline amorphous film which does not stain with eosin, and in an old thread the outer hyphae are encrusted with brown amorphous masses.

The thin border, when present, contains a network of thick-walled hyphae like those in the cord, together with fine stainable, apparently normal hyphae, about 0. 5 μ diameter, and fine, tapering, solid hyphae which do not stain with eosin. All these are embedded in a hyaline amorphous film.

In the powdery patches on the leaf, mentioned above, the hyphae of the thread spread out fanwise and are interwoven into a sheet by a network of branches. Most of the hyphae in the patch are thin-walled, 2-4 μ diameter, and exhibit septa and clamp connections. They are united by a hyaline amorphous film, in which fine, tapering, solid hyphae occur. The powdery appearance of these patches is due to incrustations of calcium oxalate.

At the tip of a cord, where it divides into a pencil of hyphae, a hyaline film, containing numerous globules and a few simple, fine, solid hyphae, underlies the thread. A small piece taken from the apex of the cord in one specimen showed a remarkable assortment of foreign bodies attached to the mycelium. These included a cymbiform, dark-brown ascospore, probably of a *Hypoxylon*, 9 x 4 μ ; another spore of the same type, 23 x 9 μ ; a septate, fusoid, brown ascospore, 14 x 7 μ ; *Diplodia* spores ; a greenish, spherical, spinulose spore, 3-4 μ diameter, in abundance, probably an *Aspergillus* ; alga cells in groups of four ; etc. The occurrence of foreign fungus spores and alga cells strengthens the supposition that the hyaline amorphous film is at some stage in its formation strongly adhesive.

As a rule, the sporophore is attached to the cord (Plate VIII, fig 2), though on old decaying leaves it may arise at a point where no cord is evident macroscopically. It springs from the top or the side of the cord, and has a short stalk, usually curved, up to 0. 5 mm. high, 0. 2 mm. diameter, lateral, longitudinally fibrillose, blackening from the base upwards. The pileus is convex, reniform or orbicular, up to 8 mm. diameter, thin, minutely pruinose, sulcate over the gills, or even. The epidermal cells of the pileus are crested with short blunt spines. The gills in the largest available examples are distant, up to six in number, adnate, ventricose, sometimes forked and with the interstices reticulated.

In the majority of the available specimens, the pilei are poorly developed, and up to 3 mm. diameter, plane, or crisped at the margin, or with a reflexed margin. Some of these have two or three fold-like gills, others have a few folds radiating from the stalk and terminating half way across the pileus, while others do not show any trace of gills.

In the dry specimens, the pileus is flexible, brownish fawn above, cream-coloured below. Mr. Bunting states that the pilei are pale coffee or cream-coloured when young, slightly darker on the dorsal surface, and become darker with age.

There would appear to be some doubt whether this species is really *Marasmius scandens* Massee. It is certainly the common White Thread Blight of the Gold Coast, and Massee's figure of the cord would not fit any other species yet seen from that region. It is also the species sent to me as *Marasmius scandens* by Tudhope soon after Massee's publication of that species. But a specimen recently sent me from the Gold Coast as the co-type of the specimen sent to Massee is the tawny-brown Thread Blight described later in this paper. There would appear, however, to have been some mistake as regards this, as the latter specimen is on a cacao branch, 3 cm. diameter, whereas Massee figures his species on a branch, 1 cm. diameter. Hence, presuming that the figure is correct,

the two specimens would be growing so far apart that, even if they were from the same tree, they might be different species.

Massee's description of the sporophore makes the reference of this common White Thread Blight to *Marasmius scandens* still more uncertain. He described the sporophore of *Marasmius scandens* as "albidus", resupinate, and arising from the thread; and he gave a figure showing the pileus with an attaching weft of hyphae at the base. That description does not agree with any of the specimens since collected. The sporophores certainly arise from the cord, but in all the available examples they are distinctly stalked. Even minute specimens which show scarcely any traces of gills have a distinct stalk. It is unfortunate that Massee did not give details of the structure of the cord, and that there is no type specimen in the Kew herbarium. Massee described the pilei as 1 mm. diameter, but figured them "natural size" as 5 mm. diameter. There does not appear to be any doubt that the thread figured by Massee is the common Thread Blight of the Gold Coast, and consequently his name for the sporophore is retained here. But it is quite possible that, as in the cases of *Stilbum nanum* and *Cyphella Heveae*, the sporophore described by Massee had no relation to the thread.

The effect of this Thread Blight on cacao, etc., has been described by Bunting in the Annual Reports of the Department of Agriculture of the Gold Coast. It has been found on cacao, coffee, jak, camphor, cola, and *Carpodinus hirsutus* Hua, and is supposed,no doubt correctly, to have spread to cultivated plants from the cola and other plants in the jungle. It is said to have killed cacao, but Mr. Bunting in 1917 stated that he had not been able to find any authentic case of death resulting from its attack. The disease is easily kept in check by pruning off and burning affected branches. The dried specimens indicate that the fungus rapidly attacks the leaf.

Attempts were made to infect cacao trees at Aburi by contact, diseased material being tied to various parts of the cacao trees. Very slow growth resulted on the main stem near the base, and in some cases the fungus, after a slight growth, died. The maximum growth on stems occurred on a sucker, eight inches in diameter (?) at six feet from the ground, the mycelium ascending for a distance of about three feet in rather more than twelve months.

Bunting states that there is no macroscopic evidence of invasion of the cortical tissue by the fungus. Where twigs have been infected, the growth has generally been a little more vigorous than on the stems, a fact which he suggests may be accounted for by the accessibility of the leaves, some of which have been destroyed oy the action of the fungus. He also remarks on the possibility that there may be other

species of Thread Blight in West Africa in addition to *Marasmius scandens*. Attempts to infect cacao with the Thread Blight from cola were not successful.

(3) Malayan Thread Blight on *Hevea*.

Of this Thread Blight, I have examined specimens collected in the Federated Malay States by Mr. F. T. Brooks, and others kindly forwarded by Mr. R. M. Richards from Province Wellesley. In each collection there appears at first sight to be two forms.

In the first form, the mycelium occurs on branches about 1cm. in diameter, and is almost entirely confined to one side (Plate VII, fig. 2). The main cord runs longitudinally along the stem and gives off, at an acute angle, branches which anastomose with one another and with the main cord and form a network. On a stem 1.5 cm. diameter, there are two parallel main cords, the branches of which meet and fuse. The main cord is stout, up to 1.5 mm. broad, but its breadth may vary from 0.5 to 1.5 mm. within a distance of 3 cms. The lateral branches are usually narrower, and may be only 0.15 mm. broad. It frequently forms flat expansions, especially where two cords meet, but the membranous margin which occurs in other species is usually very narrow and often absent. The main cord is prominent, rounded above, up to 0.5 mm. thick, minutely tomentose, becoming glabrous. It is white at first, but acquires a brownish tinge when old. In longitudinal tangential section it appears white internally, but a transverse section shows a brownish tinge.

The cord internally is more or less felted or spongy, the hyphae being more interwoven than in other species in the outer layers. The hyphae are 1.5 to 3 μ diameter, and of the usual Thread Blight type. Knee bends are not common. The hyphae frequently bear oval swellings, sometimes two together (Plate IX, fig. 16). All the interior hyphae stain with eosin.

On the exterior of the cord the hyphae are encrusted with amorphous masses and minute granules, and the surface is covered here and there by an amorphous hyaline sheet in which the minute granules are embedded. Some of the hyphae at the exterior do not stain with eosin; these are usually minutely verrucose. There are no anker cells, and the cord is remarkable chiefly for the absence of any free clavate tips or very fine hyphae, such as occur in other species.

Thin-walled septate hyphae, up to 6 μ diameter, occur sparingly at the base of the cord. Near the growing point, where some of the hyphae are also thin-walled and septate, clamp connections may be found.

All the hyphae stain strongly with cotton blue.

One specimen shows this Thread Blight on a *Hevea* leaflet. The cord forms a small pad on either side of the mid-rib at the base of the leaf on its lower surface, and from each of these a cord runs along the mid-rib. One of these soon leaves the mid-rib and runs outwards the margin, thinning out so as to be scarcely visible. The other follows the mid-rib to the apex, crossing it from side to side, occasionally looping out over the leaf, and giving off a few very fine branches which spread outwards the margin. There is no general film over the under surface of the leaf. Consequently it would appear that this is not the Thread Blight described by Bancroft from Malaya.

Of the second form, one specimen, on a stem 1.3 cm. diameter, bears a main cord which runs irregularly along the stem, giving off fine branches at varying angles, but usually at a large angle. A second specimen (Plate VII, fig. 1) is on a stem 3.5cm. diameter, and the mycelium covers three-quarters of the circumference of the stem ; it runs in five main cords, more or less parallel to one another, but with sudden abrupt bends ; the angle of branching varies, but in general it is a large one. These bends are peculiar, in that the thick cord turns sharply to one side, but leaves a thin branch which grows on for a short distance in the original direction of the thread.

This second form looks different from that described above, because the cords are thinner, and the angle of branching is, on the whole, different. The microscopical examination of the cord, however, shows that it is identical in structure with the first, and it is most probably the same species.

Dr. C. Bernard has furnished me with specimens, apparently the same species, of Thread Blight on *Hevea* from Sumatra. The cord on a thin stem or on a petiole is in general unbranched, but on one petiole it forms a network. On reaching the leaf it divides fanwise and runs over the leaf in definite flexuose strands which make sudden bends. These bends are of the same peculiar form as those on the stem previously described. When two leaflets are fastened together by the fungus, it spreads from the point of attachment in a more copious development of somewhat diffuse radiating strands.

This species does not appear to cause damage to woody stems, as far as the available specimens show, but it kills the leaves when it runs over them. Its fructification is not known. In the absence of any Thread Blight in the type specimen of *Cyphella Heveae* it is impossible to say whether the latter name was intended to apply to this species.

(4). White Stem Blight.

Though this is not a Thread Blight, according to the planters' classification, in one of its forms, it nevertheless possesses a cord similar to that of the Thread Blights, and it becomes a true Thread Blight in in some situations. It has been found in Ceylon on *Hevea*, tea, and teak (Plate I, fig. 4).

In the case of *Hevea*, it usually occurs on semi-vertical branches, about 6 cms. diameter or less. Viewed from the ground, the affected branches look as though they had been whitewashed on the lower side, sometimes for a length of six feet, a white or greyish-white patch extending continuously along the branch and about half-way round it. Occasionally, white lines or bands, up to 1 cm. broad, extend in a zigzag fashion from the margin of the patch on one side, over the upper surface of the branch, and unite again with the patch on the other side, while in some instances similar white lines proceed longitudinally along the branch on its upper surface.

On examination with a hand lens, it is seen that there is no continuous sheet of mycelium over the whitened area. The surface is cracked and roughened as on normal *Hevea* stems and all the minute bark scales are clearly evident. If the specimen is left to dry in the laboratory, these scales fall off like flakes of bran.

On closer examination, one finds more or less rounded cords, up to 0.15 mm. diameter, running along the white patch. These usually are continuous only for a short distance, sometimes only for a length of a centimetre, and then enter a crack and divide up into hyphae which are lost between the bark scales ; but on the white lines and bands there is generally a continuous white cord running along the centre.

At the edge of the white patch, more especially at the upper edge, mycelium is sometimes plainly evident in very thin fimbriate strands, closely applied to the bark, which become shining and silvery. Fine strands of hyphae run in the cracks in the bark and spread out in sheets over the surface. These may be visible for a breadth of 2 cms. at the margin, and traces may be found as shining membranous patches, about 5 cms. from the edge, but in the specimens examined there is no indication of these patches over the general surface of the white area. It would appear probable that this development of mycelium may only occur under certain weather conditions. From the character of the bark it does not seem possible that this marginal mycelium is formed in the early stage of development of the white patch and weathers off later.

The cords on the white patch are composed of flexuose, more or less parallel hyphae, 2-2.5 μ diameter, thick-walled or solid, resembling

those of the Thread Blights in general. They may be solid for the greater part of their length, with a narrow lumen here and there. In the centre of the cord some of the solid hyphae are up to 5 μ diameter, and are composed of segments, with ends inflated up to 8 μ diameter, which readily separate from one another. The outer hyphae of the cord give off fine branches, 0.5 μ diameter, usually simple, which bear spherical or oval hyaline globules, up to 1.5. x 1 μ, either sessile on the hypha or at the apex of short lateral branches up to 2.5 μ long. These lateral branches are sometimes clustered, and they may be forked. The fine hyphae sometimes fuse into a hyaline film spreading over the bark from the edge of the cord, and, when old. the outer layer of the cord is a continuous thin amorphous sheet which is apparently formed from them.

Over the general surface of the white patch, hyphae, 2-5 μ diameter may be found, running singly or in small bundles in the cracks in the dead bark and giving off fine hyphae, 0.5 μ diameter, which permeate the dead cells.

The dead bark on the upper branches of *Hevea* consists of alternate layers of thin and thick-walled rectangular cells. In the specimen examined, the minute scales into which the outer layers were cracked consisted of an external layer of thin-walled cells, one cell deep, followed by a layer of thick-walled cells, four cells deep. Beneath these the bark was continuous, and was composed of a layer of thick-walled cells, 2 cells deep, followed by a layer of thin-walled cells, 2-3 cells deep, and then another layer of thick-walled cells overlying the living tissues. The walls of the thick-walled cells are up to 10 μ thick, with narrow pits.

The larger hyphae run in the cracks between the outer scales, and penetrate between the cells. The fine hyphae penetrate the cell wall and are abundant in the thin-walled cells of the outer layer of the scales, but occur more sparingly in the thick-walled cells where they pass from one cell to another *via* the pits. In the continuous bark layers, the mycelium is scanty ; here and there, the larger hyphae may be found running between the cells, and a few fine hyphae in the thin-walled cells. The mycelium has not been observed in the living tissues.

The white appearance of the stem is partly due to a sparse covering of mycelium which does not obscure the normal structure of the surface, but chiefly to the presence of minute bark scales which have been bleached and loosened by the fungus.

The fringe of mycelium at the edge of the white patch contains all the elements already described. Some of the hyphae there, however, are thin-walled and bear clamp connections. These clamp connections are usually situated opposite the point of origin of a branch, i.e., the

clamp connection arises, just below a septum, at one side of a hypha, and a branch in the corresponding position at the other side.

On *Hevea*, this species has been observed only on old branches, and consequently at a considerable distance from the leaves. There has therefore been no opportunity of noting its effect on the leaves of *Hevea*.

This fungus has been found on tea in the low-country of Ceylon. The appearance of the affected stems is in general similar to that in *Hevea*, but, the stems being thinner, the white patch encircles them. In some cases, the fungus began on stems about 2 cms. diameter, and ran upwards to the tips of the plucked shoots, whitening them uniformly all round. The cords of mycelium which overrun the white area are up to 0.2 mm. in breadth, often discontinuous, and usually flat and inconspicuous. On the thinner twigs they become stouter and more elevated.

Dead leaves or twigs which fall from the upper part of the bush and come in contact with the white patch are fastened to the stem by mycelium from the latter, whether in contact with a cord or with any part of the whitened surface.

At the base of a petiole, the fungus usually forms a small felted pad. From this it runs up the under side of the petiole in a rather broad tomentose cord and spreads out fanwise over the lower surface of the leaf in fine, somewhat feathery strands. The mycelium rarely extends over more than the basal half or two-thirds of the leaf.

On several branches on a bush on which most of the stems were whitened up to the apex, the white area terminated at a point about eight inches from the top, while the cord was continued upwards over the stem and the leaves. On the upper parts of these branches the fungus was merely an ordinary Thread Blight. The cord is stouter than that on the whitened patch and has usually a glabrous wrinkled surface. It branches at an acute angle, and rarely forms a network. Frequently the lateral branches of the cord spread out in small tomentose patches, or similar patches are formed at the side of the thread. At the base of a petiole it forms a pad, as in the form already described, and runs up to the leaf along the lower side of the petiole in a broad felted strand, but it does not divide up on the leaf blade into as many strands as in the former case, and in some instances the under surface of the leaf bears only three or four strands, of which one along the mid-rib may be as stout as the cord on the stem.

The effect of the fungus on the stem of the tea bush is similar to that on *Hevea*. The minute bark scales are loosened and fall off when the stem dries. The finer hyphae penetrate into the continuous cork

layer and pass from cell to cell through the pits. These hyphae have been found sparingly in the living cortical tissue and in the wood. As, however, this observation was made on stems which had been cut off and simply air-dried, there is some doubt whether this penetration occurs in the living stem. The thicker branches do not appear to be injured by the fungus, but the upper parts of the twigs may be killed.

When the mycelium spreads over the leaf, each strand is at first bordered by a narrow watery-green zone. The area covered by the mycelium soon dies, and, in the case of tea, becomes thin, papery, and yellow-brown, contrasting strongly with the terminal part of the leaf, which has died without being attacked by the fungus and is consequently dark brown. This appearance appears to be peculiar to this disease.

A somewhat different effect was noted on a few leaves, which had only recently been overrun by the mycelium. The strands on these were only about 30 μ broad, and would have been scarcely visible but for their effect on the leaf. Each was situated on a narrow watery green line, which, at fairly close intervals, expanded into circular areas, up to 0.2 mm. diameter. Consequently, the leaf bore watery green lines, beaded at close intervals, with a white line down the centre. When the leaf was dried, these circular areas became grey, but they are not covered by a pad of hyphae. Under each circular area the leaf is thickened. This is especially noticeable on the dried leaf, as the patches then form elevated areas, about 0.2 mm. diameter. The thickening is due to an increase in the number of cells, and the thickening of the cell walls, of the spongy parenchyma. These circular areas are often situated round a stoma, and stomata under or near a strand may be blocked by mycelium, though this is not universal. The hyphae may enter the leaf through a stoma or through the epidermis. On the other hand, a hypha may cross a stoma without entering the leaf. The hyphae penetrate the cells at random, and may be present in the palisade layer before the leaf shows any effect, except the watery green line.

After the death of the leaf, the cord or felted patch on the petiole and the strands on the leaf blade become thicker, grey-brown, and tomentose. The strands may spread out into compact felted patches, 2-3 mm. long and broad, especially along the mid-rib. They are then dense internally, often with a well-developed outer layer of free hyphae, which are pale brownish, flexuose and interwined, 3-4 μ diameter, and up to 0.4 mm. long. At the margin of the yellow patch, there is often a delicate film of hyphae, forming a thin sheet, which may appear powdery, owing to a strong incrustation of calcium oxalate on the free ends of the hyphae. When the leaf decays, the base of the petiole, or sometimes

the petiole and the mid-rib, remain attached to the stem by the mycelium at the base of the petiole and the cord along the mid-rib.

The fully-developed fructification of this species has not been obtained. Fructifications have been found on the leaves of a tea bush attacked by White Stem Blight, but, judging from the similar case of *Marasmius pulcher* they are most probably to be regarded as not completely developed. They occurred on leaves which bore fine white threads radiating from the base of the leaf or from a point at the edge of the leaf where the latter was in contact with, and united by the mycelium to, a whitened stem. The threads are narrow, up to 0.2 mm. broad, thin, silvery, branching frequently, and diminishing towards the tips. In places, the threads are only one hypha thick, the individual hyphae running side by side over the surface of the leaf united by a hyaline film. These threads do not appear to cause any damage to the leaf. The constituent hyphae are 3-4 μ diameter, regular, septate, with a thin, or moderately thickened, wall; they are more regular than the hyphae in the cord on the stem and approach the shape of *Corticium* hyphae.

The fructifications form small, white, circular or oval patches, up to 2 mm. diameter. They are attached to the leaf over the whole of their dorsal surface, and a white fringe of hyphae extends from them over the leaf. The upper surface is glabrous, and the margin slightly elevated. Sometimes they are incised on one side, but no trace of gills has been noted. The total thickness of the fructification is about 0.1 mm. The upper layer is composed of closely packed basidia, about 18 μ high, 4-5 μ diameter, four-spored, with hyaline, oval spores, 5-6 x 3 μ.

On the available specimens, there is no reason why this fructification should not be classed as a *Corticium*, but it would seem probable that it is really an imperfect development of a *Marasmius*. Similar pilei, lacking gills, occur in *Marasmius pulcher* and *Marasmius scandens*.

It is remarkable that the leaves which bear these fructifications of the White Stem Blight do not exhibit any signs of injury by the fungus. This behaviour is similar to that of the *Corticium* which causes Black Rot of tea.

The specimen on teak consists of the terminal portion of a leafy shoot. The young stem is not whitened, but the specimen is insufficient to show whether this occurred on the older woody stem below. The cord on the stem is stout, about 0.3 mm. broad, elevated, continuous, branching and forming a network, sometimes with byssoid patches spreading from the cord. On the older parts, the cord is dark-brown or blackish externally, but the hyphae are not coloured.

The effect on the leaves is the same as on tea, the part of the leaf covered by the mycelium, about half the leaf, turning yellow-brown.

The mycelium forms a pad at the base of the petiole and travels up the stout petiole in one or more cords which branch and anastomose. Similarly, the mid-rib may be covered with a network of cords, while branches from these travel outwards along the prominent lateral veins. From the latter, hyphae spread out over the surface of the leaf in finer strands or thin, byssoid patches. In some instances, the restriction of the main cords to the veins is very marked, but in others the cords run at random from the mid-rib or from the base of the leaf. Compact, tomentose, grey-brown patches are frequent, especially by the side of the mid-rib.

Though no whitening of the stem has been observed in the case of teak, there is little doubt, from the structure of the thread, etc., that the fungus in this case is the same as that of the White Stem Blight of *Hevea* and tea.

(5) Brown Thread Blight, Ceylon.

This Thread Blight was found in the Botanic Gardens, Peradeniya, on an exotic tree, *Garcinia cornea* L. It occurs towards the ends of the branches, on twigs about 5 mm. diameter or less.

The cords are somewhat flattened, at first white, becoming pale brown, with a white, spreading, pruinose margin. The brown thickened cord is about 0.5 mm. broad, and the total width, including the thin margin, about 1 mm. It runs more or less longitudinally along the branch, branching freely and anastomosing to form a network. Here and there it expands into rather thick, pale brown or fawn, tomentose patches. It passes from the stem to the leaf stalk, but has not been observed to spread over the leaf. The brown cord is looser than in other Thread Blights: its surface, especially towards the growing point, may be longitudinally fibrillose, and its constituent hyphae, or at least those in the interior, separate readily when the cord is teased out.

The main hyphae of the cord are 2-3 μ diameter, yellowish-brown, thick-walled or solid. They are more regular than in other species, but have the same general structure. Swellings with a narrow internal cavity (? old clamp connections) are common, and intercalary oval swellings, up to 20 x 12 μ, with a large cavity, which somewhat resemble anker cells, occur in the solid hyphae (Plate IX, fig. 17). On the exterior of the thread, the hyphae bear minute hyaline granules, and the same granules occur in small masses between or over them. These hyphae stain with eosin, but the granules do not.

Thin-walled, septate hyphae not been observed at the base of the thread. The extreme basal layer is hyaline, does not stain with eosin,

and appears to be composed of disorganised hyphae. Towards the growing point, septate hyphae, 3 μ diameter, occur, and these bear clamp connections.

In the film at the side of the cord, the hyphae are hyaline, 1-2 μ diameter, thick-walled or solid. All the film is strongly encrusted with irregular masses of calcium oxalate. The hyphae are strongly encrusted with minute hyaline granules, and bear free clavate branches, up to 10 μ long, similarly encrusted, or spinulose. Small masses of the same granules also occur between the hyphae. The thick-walled hyphae bear, somewhat sparingly, fine hyphae, 0.5 μ diameter, which may be simple or branched. The main hyphae of the film form a network which fuses into a continuous sheet. In many cases, hyphae which diverge from the main cord branch at their extremities, and the branches expand into hyaline films (Plate IX, fig. 18). The spaces between the hyphae are filled by a hyaline amorphous membrane, in which fine hyphae and innumerable granules are embedded.

This Thread Blight does not appear to injure the tree. No fructification has yet been observed.

(6) Brown Thread Blight. West Africa.

Three gatherings of this species on cacao and kola were included in a collection of Thread Blights kindly forwarded to me by Mr. R. H. Bunting.

The thread occurs on the stems and leaves. On the latter it branches at a fairly wide angle and spreads out over the leaf, sometimes extending over nearly the whole of a cacao leaf. In one gathering, the thread is on the upper side of the leaf, but in the other two it is on the lower side.

The thread is tawny brown, slightly longitudinally fibrillose. It is not bordered by a white film, as in the corresponding Ceylon species. The hyphae are yellow-brown, 2-4 μ diameter, of the usual Thread Blight shape, but with walls only moderately thickened. Septa are frequent, and many hyphae show normal branching, the lateral branch arising just below a septum. Hyphae which spread out from the cord over the leaf tend to fork and form expansions at their extremities, but this is not as well-marked as in the parallel Ceylon form. Fine hyphae have not been observed. The yellow-brown hyphae do not stain with eosin.

One example bears immature pilei, and fragments of mature pilei, attached to the thread. The immature pilei are small pezizoid structures, cup-shaped, 0.2 mm. high, 0.3 mm. diameter, white pruinose externally. The fragments are strongly brownish white pruinose externally, with

a red-brown hymenial layer. The outer (upper) surface bears irregular hyphae, 4 μ diameter, rough with projecting points or elongated spines, or bearing short bristle-like appendages, and encrusted with calcium oxalate.

It is probable from the specimens available that the fructification of this species is a *Marasmius*.

(7) Purple-brown Thread Blight, West Africa.

Two examples of this species on cacao were present in the collection of Thread Blights from the Gold Coast, one on a stem and the other on a leaf. On the stem, the cord is unbranched and runs irregularly along it. On the leaf it occurs on both sides, but chiefly on the upper, radiating from a point near the margin where a dead twig is attached to the leaf. The colour is dark purple-brown, appearing almost black (Plate VI, fig. 2).

The thread on the leaf, towards the point of origin, is stout, rounded, up to 0.4 mm. broad, with a broad thin margin, up to 0.6 mm.wide. It branches repeatedly, the branches becoming progressively finer and pale-brown towards the tips. The exterior hyphae are yellow-brown by transmitted light, and form a continuous cortical layer. The internal hyphae are hyaline, flexuose, 2 μ diameter, thick-walled or solid. The thin margin is chiefly a network of hyphae, united by an amorphous film which is either brown or hyaline. A few clavate branches bearing short fine hyphae, are also present. In some places, the hyphae at the margin of the thread are united laterally into a sheet which recalls the cover of a Microthyriaceous perithecium, but in others they form a wide-meshed network.

No fructification of this species has been observed. In the differentiation of the hyphae into a coloured outer layer and a hyaline inner tissue, the cord resembles that of the Horse-hair Blights.

(8) Brown Thread Blight on Cacao, West Indies.

A specimen of a brown Thread Blight on cacao was kindly sent me from the West Indies by Mr. W. Nowell. It had been preserved in alcohol, and the colours described are those after drying.

The cord is on a stem 5-6 mm. diameter, along which it runs more or less regularly, giving off branches to the lateral twigs. It is about 0.4 mm. in diameter, somewhat elevated, rounded above, dark red-brown, smooth. Internally it is white, or brownish white. The hyphae are

3-5 μ diameter, thick-walled or solid, flexuose, with knee bends, and suddenly inflated here and there from 3 to 4 or 5 μ, but without any large swellings. There are no special fine branches in the available specimen, and neither septa nor clamp connections were found, even in the basal layer. The red-brown colour is due chiefly to a brown deposit on or among the outer hyphae of the thread.

The cord bears hemispherical, or irregularly pulvinate, cushions, up to 4 mm. diameter, wide apart, or close together and confluent. These are white, spongy, with the outer layer interwoven into a more or less glabrous sheet. The hyphae of which they are composed are loosely intertwined, 3-4 μ diameter, thin-walled and collapsing, or thick-walled with a narrow lumen, or solid, flexuose and irregular in diameter. Septa were not found.

The hyphae of the cushions are similar to those of the thread. They stain with cotton blue, but not with eosin.

In general appearance, and in their spongy nature, the cushions of this species resemble those of the *Corticium* on tea from Sumatra. But the thread is a different colour, and the hyphae differ completely, being those of a *Marasmius* Thread Blight, not those of a *Corticium*.

This species resembles *Corticium Stevensii*, which has been recorded from the West Indies, in the colour of the thread. The cushions, however, differ in colour on the available specimen, and they are not sclerotia, but consist of merely loosely interwoven hyphae. Further, the hyphae of the thread of *Corticium Stevensii*, as described by Stevens and Hall, are regular and septate, as is usual in the *Corticium* Thread Blights, while in the present species they are irregular and do not show septa.

It would appear, therefore, that there are two brown Thread Blights in the West Indies, which resemble one another closely in macroscopic characters, but differ in the character of their hyphae.

SUMMARY.

In the Thread Blights of the Eastern Tropics which have been found to belong to species of the genus *Corticium*, a large proportion of the hyphae of the cord are thin-walled and of normal structure, while the remainder, though thick-walled, are regular and have a distinct lumen and unthickened septa. Solid hyphae have been observed in one species of this group. A thin hyaline membrane unites the hyphae in expansions at the side of the cord, or in membranous coverings on the leaves, and assists in fastening the mycelium to the host.

A progressive development of the mycelium may be traced in these aerial species of *Corticium*. In the species which causes the Black Rot

of tea, the hyphae are thin-walled and do not coalesce to form a visible thread. In *Corticium Theae*, the hyphae unite into a cord, and the majority of the hyphae in the cord are thick-walled. Black Rot of tea is essentially a wet-weather disease, and the fungus on the stem appears to die off when the rains cease. In *Corticium Theae*, the thread is persistent, though it shrinks on drying.

It appears to be possible, at least in the East, to distinguish the *Corticium* Thread Blights from other species by the character of the hyphae.

The other Thread Blights described in this paper agree with one another, and differ from the *Corticium* Thread Blights in having the greater part of the hyphae of the cord irregular, thick-walled or solid. In these hyphae, septa and clamp connections are, in general, lacking. Berkeley stated that the hyphae of the species examined by him had no joints, as far as he could ascertain. Where the fructification is known, it has been found to be a *Marasmius*, and consequently this group has been designed Marasmioid Thread Blights, though it has to be admitted that in the majority of these forms the fructification has not yet been determined. The remainder of this summary refers to these Marasmioid Thread Blights.

Thin-walled hyphae may be found, in most species, at the base of the cord, and (though not universally in the one species) at the growing point, or in the film at the side of the cord and on the leaf, and in some instances, on the exterior of the thread. The latter occurrence is perhaps dependent upon weather conditions, i.e., a period of high rainfall. These hyphae are septate and may bear clamp connections.

Cases of partial absorption of the septa may be observed in the thin-walled hyphae (Plate IX, figs. 10, 12), and it appears probable that all the septa are absorbed before the wall of a hypha is notably thickened. The growth in thickness of the cord would appear to be accomplished by the addition of hyphae from below, the hyphae being subsequently converted from thin-walled into thick-walled, or solid, hyphae. But as some of the hyphae at the base of the cord are, in some species, more than double the diameter of the thick-walled hyphae, it would appear that these hyphae may remain permanently as thin-walled basal hyphae, possibly serving for transference of food and constituting a permanent meristematic tissue.

The clamp connections of the thin-walled hyphae are probably represented by swellings on the solid or thick-walled hyphae. Swellings which have a narrow lumen, as in Plate IX, fig. 17 (right) and 2 (right),

are strongly suggestive of thickened clamp connections, the lumen representing the space between the parent hypha and the curved connecting link.

On the solid, or thick-walled, hyphae, branches are difficult to find. The thin-walled hyphae branch at a medium angle. From examples, such as that in fig. 11, Plate IX, it appears that when the walls of the hyphae become thickened, the lateral branch or the parent hypha may degenerate, at least near the fork. The position of the former bifurcation is then indicated by an angular projection or a knee bend. Fig 11 shows an angular projection in the lower part of the hypha, and a degenerating branch arising from a similar projection above. In a few instances however, both the parent hypha and the branch become thick-walled (Plate IX, fig. 2).

In nearly all the species examined, the hyphae at the exterior of the cord give off very fine branches, less than 1 μ in diameter, either simple or branched, and apparently solid. In one species, *Marasmius pulcher*, these fine hyphae bear branches more or less in whorls, and thus resemble conidiophores. In all the species which possess these fine branches, they are especially abundant in the narrow film at the side of the thread, and in the film on the leaf. In the latter, they appear in the earliest stage of its formation.

At the exterior of the thread, all the hyphae are usually more or less encrusted with minute, hyaline, solid globules. These occur both on the thick-walled hyphae and on the very fine hyphae, and on the latter they resemble conidia.

The globules and the fine hyphae at the exterior of the cord become embedded in a thin, hyaline amorphous membrane. This occurs also at the base of the film at the side of the thread or on a leaf. It is probable that this membrane is formed by an excretion from the hyphae, and that the fine conidiophore-like hyphae are in some way connected with this excretion. The nature of this membrane and the globules has not been ascertained. The membrane does not disappear in alcohol, but it appears to be dissolved to some extent, as specimens of Thread Blights preserved in alcohol readily separate from the host plant.

In staining with eosin, the globules, the finer hyphae, and the amorphous membrane do not stain. In the Thread Blights which possess anker cells, the walls of the remaining hyphae do not stain with eosin, but in those which lack anker cells, the walls of these hyphae, in general, take the stain. In the Malayan Thread Blight on Hevea, however, which is one of the species without anker cells, the inner thick-walled hyphae stain with eosin, but those on the exterior of the thread, which are rough with hyaline globules, do not stain.

The occurrence of very thin, hyaline, amorphous membranes is a fairly common phenomenon in tropical fungi. Burt has noted it in *Corticium Koleroga*; in discussing (and rejecting) Cooke's statement that the fertile patches of this species are gelatinous, he remarks, " However, when, in the case of other collections, I moisten the fructification on the leaf and detach it from the surface of the leaf with the point of a scalpel, I do detect in places from along the very surface of the leaf a very delicate transparent membranous structure suggestive of the hypothallus of such a myxomycete as *Stemonitis*, but much more tenuous and delicate." It is a membrane of this nature which makes the first stages of the Thread Blight on a *Strobilanthes* leaf appear silvery when viewed obliquely. It may be noted that if leaves bearing *Corticium Koleroga* are preserved in alcohol, the fructification floats off the leaf as a thin film when the bottle is shaken. That this film is in some species adhesive at some stage of its formation is evident from the foreign bodies, fungus spores, etc., which are found adhering to the thread.

Membranes of this character are found commonly in fungi which occur on leaves, but are not parasitic, or only feebly parasitic, on the plant. In Horse-hair Blight (*Marasmius equicrinis* Berk.),the hyphae of the attaching discs are united by a membrane of this character, and the mycelium separates from the host when the specimen is preserved in alcohol. In *Aschersonia* and *Hypocrella*, the hypothallus often consists of a similar membrane. In the species of *Torrubiella* on scale insects, the basal layer of the stroma and hypothallus is membranous, and in some species the membrane contains globules and fine hyphae similar to those which occur in the membranes of the Thread Blights. In the *Microthyriaceae*, a similar membrane sometimes extends over the leaf from the minute perithecia, uniting the perithecia over the greater part of a leaf; in some cases, a few hyphae are embedded in it, forming a wide-meshed network, in others it is wholly amorphous.

It may be suggested that the substance which forms these membranes is similar to that which causes the varnished surface of *Fomes lucidus*, etc. In *Fomes lucidus*, as it occurs in the tropics, the developing pileus is at first white and its surface is not laccate. As it increases in size the older parts become yellow and laccate, and the colour gradually changes to the red or mahogany of the mature pileus. Thus, in an actively growing pileus, the margin for a breadth of about one inch will be white and not laccate, the zone immediately behind this will be yellow and varnished, while the older part will have the normal character of the mature pileus. In *Polyporus colossus* the condition is the same; the growing margin is not laccate. I am not aware that the method of formation of this laccate crust has been investigated.

With regard to the association of the finer hyphae with membrane formation, and their resemblance to conidiophores, the following parallel may be recorded. *Fomes lamaoensis* Murr. clothes the roots of the plants it attacks with a tawny brown, interwoven mycelium. When old, this mycelium acquires a thin, brittle, black, outer crust. In some cases this crust bears powdery brown patches, and these are found to consist apparently of branched conidiophores, bearing terminal, oval, yellow-brown conidia. Further examination, however, shows that these apparent conidia are solid globules. The full investigation of this has not yet been completed, but it appears that these hyphae and globules normally take part in the formation of the black crust. Where the powdery patches occur, the crust has apparently been formed at a deeper level in the mycelium and the pseudo-conidiophores have been left outside it, just as, in the formation of some sclerotia from a weft of hyphae, e.g., *Sclerotium stipitatum*, only the inner hyphae form the sclerotium, the outer hyphae being cut off and ultimately dying.

Thread Blights are not necessarily confined to bushes growing under shade. The parasitic species on *Gymnosporia* occurs in the Botanic Gardens, Henaratgoda, on an isolated bush in the open, exposed to full sunlight, in a district which is subject to a partial drought for two months in the year.

That the superficial mycelium should be able to survive such conditions is no doubt due to the character of the hyphae of the thread. The majority of the hyphae which compose the thread are thick-walled or solid,—are, in fact sclerotioid, Thin-walled hyphae occur normally only towards the base of the thread, in which situation they will be protected from dessication by the compact mass of sclerotioid hyphae.

The primary function of the hyaline membrane is most probably to attach the cord to the host plant, as in other species of fungi. But in the Thread Blights, this membrane also covers the cord, at least in the older parts. In that situation, it may be presumed that it serves to hinder evaporation from the cord during dry weather, and thus furnishes another means of protection from dessication.

It is quite common, especially on tea, to find the Thread Blight cord originating from a point where a dead leaf bearing the mycelium has become attached to the stem ; and there is no doubt that the dispersal of infected leaves by the wind is effective in extending the local distribution of these fungi. But that is not true of all infections, and it is doubtful whether that method would be effective over long distances. It would appear more probable that the appearance of Thread Blight in localities hitherto unaffected is due to a distribution of spores. It may

be noted that, in general, the spores of the tropical species of *Marasmius* germinate readily ; they will germinate in a spore print left overnight.

No further evidence has been obtained as to the nature of the structures known as anker cells.

Most of the Thread Blights are parasitic, though they do not cause much damage except on leaves and young stems. *Marasmius pulcher* is epiphytic.

The fully-developed fructification of the marasmioid Thread Blights has been found in the case of two species only, viz. *Marasmius pulcher* (B. & Br.), of Ceylon and India, and *Marasmius scandens* Massee, of West Africa. In the case of White Stem Blight, a fructification has been found, which is probably an imperfectly developed *Marasmius*.

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EXPLANATION OF PLATES.

Plate I. Fig. 1. *Corticium* sp., with hyphal cushions, on tea, nat. size.
Fig. 2. *Corticium Gardeniae*, on *Rubiaceae*, x 4/5.
Fig. 3. *Corticium Theae*, on tea, x 4/5.
Fig. 4. White stem blight, on tea, natural size.

Plate II. Effect of Black rot on Coca ; leaves on the left not attacked ; nat. size

Plate III. Thread Blight on old and young stems of *Gymnosporia*, nat. size.

Plate IV. Fig. 1. Zimmermann's cobweb fungus on tea, nat. size.
Fig. 2. Young fructifications of *Marasmius pulcher*, on *Garcinia*, nat. size.
Fig. 3. Thread Blight (*Marasmius pulcher*) on *Garcinia*, nearly nat. size.

Plate V. Fig. 1. Thread Blight (*Marasmius pulcher*) on nutmeg leaf, natural size.
Fig. 2. Thread Blight (*Marasmius pulcher*) on nutmeg, x ½.

Fig. 3. Thread Blight (*Marasmius pulcher*) on old tea stem, x $\frac{1}{4}$.

Fig. 4. Thread Blight (*Marasmius pulcher*) on nutmeg, passing from a dead twig to a leaf, x $\frac{1}{2}$.

Plate VI Fig. 1. Thread Blight (*Marasmius scandens*) on cacao stem, x 5/6.

Fig. 2. Purple-brown Thread Blight on cacao leaf, spreading from a dead twig, x $\frac{3}{4}$.

Plate VII. Fig. 1. Thread Blight on *Hevea*, x 6/7.

Fig. 2. Thread Blight on young *Hevea* stem, x 5/8

Plate VIII. Fig. 1. *Marasmius pulcher*, imperfect fructifications (*Cystella pulchra* B & Br.) on dead nutmeg leaf, x 8.

Fig. 2. *Marasmius scandens*, on cacao leaf. x 2.

Plate IX. Fig. 1. Hyphae of *Corticium Gardeniae*, that on the left with thickened walls but comparatively thin septa, x 500.

Fig. 2. Hyphae from the Indian parasitic Thread Blight on tea, showing various stages of thickening of the walls. Starting from the left, the first two are moderately thick-walled; the third solid, except for a narrow lumen over part of its length; the fourth and fifth solid, the latter in irregular joints; the sixth branched and moderately thick-walled; the seventh branched and in part solid; the eighth solid; the ninth solid, except for a small cavity situated below a lateral swelling (? a clamp connection). All x 800.

Fig. 3. Anker cells from the Indian parasitic Thread Blight on tea, x 450.

Fig 4 Toothed hyphae from the Indian parasitic Thread Blight on tea, x 1,000.

Fig. 5. Fine hyphae, with granules, from the Indian parasitic Thread Blight on tea, x 400.

Fig. 6. Clavate tip from the Indian parasitic Thread Blight on tea, x 1,000.

Fig. 7. Anker cells of the Javan Spinnenwebeziekte (after Zimmermann).

Fig. 8. Toothed hypha from the Javan Spinnenwebeziekte (after Zimmermann).

Fig. 9. Anker cells from the Ceylon parasitic Thread Blight on *Gymnosporia*, x 450.

Fig. 10. Stout thin-walled hypha, with septum partly

absorbed, from the Ceylon parasitic Thread Blight on *Gymnosporia*, x 800.

Fig. 11. Hypha from the cord of *Marasmius pulcher*, with degenerating side branch, x 800.

Fig. 12. Branched hypha from the cord of *Marasmius pulcher*, showing absorption of septum, x 800.

Fig. 13. Solid hyphae from the cord of *Marasmius pulcher*, x 800.

Fig. 14. Ultimate fine branches of the hyphae of *Marasmius pulcher*, x 1,000.

Fig 15. Inflations on the hyphae of *Marasmius scandens*, x 600.

Fig. 16. Parts of hyphae from the Malayan Thread Blight on *Hevea*, x 600.

Fig. 17. Inflations on the solid hyphae of the brown Thread Blight on *Garcinia*, Ceylon, x 400.

Fig. 18. Terminal portions of the hyphae from the margin of the brown Thread Blight on *Garcinia*, x 750.

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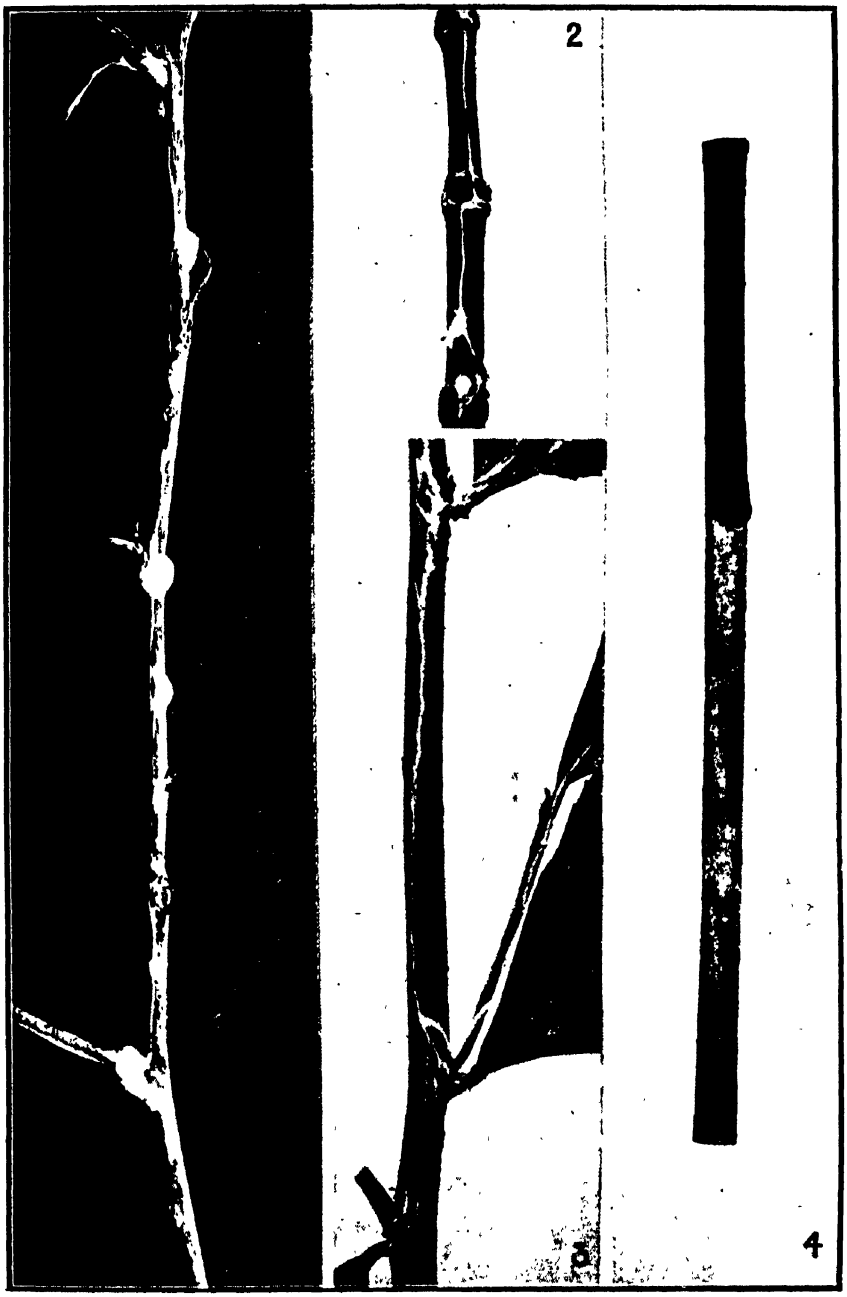

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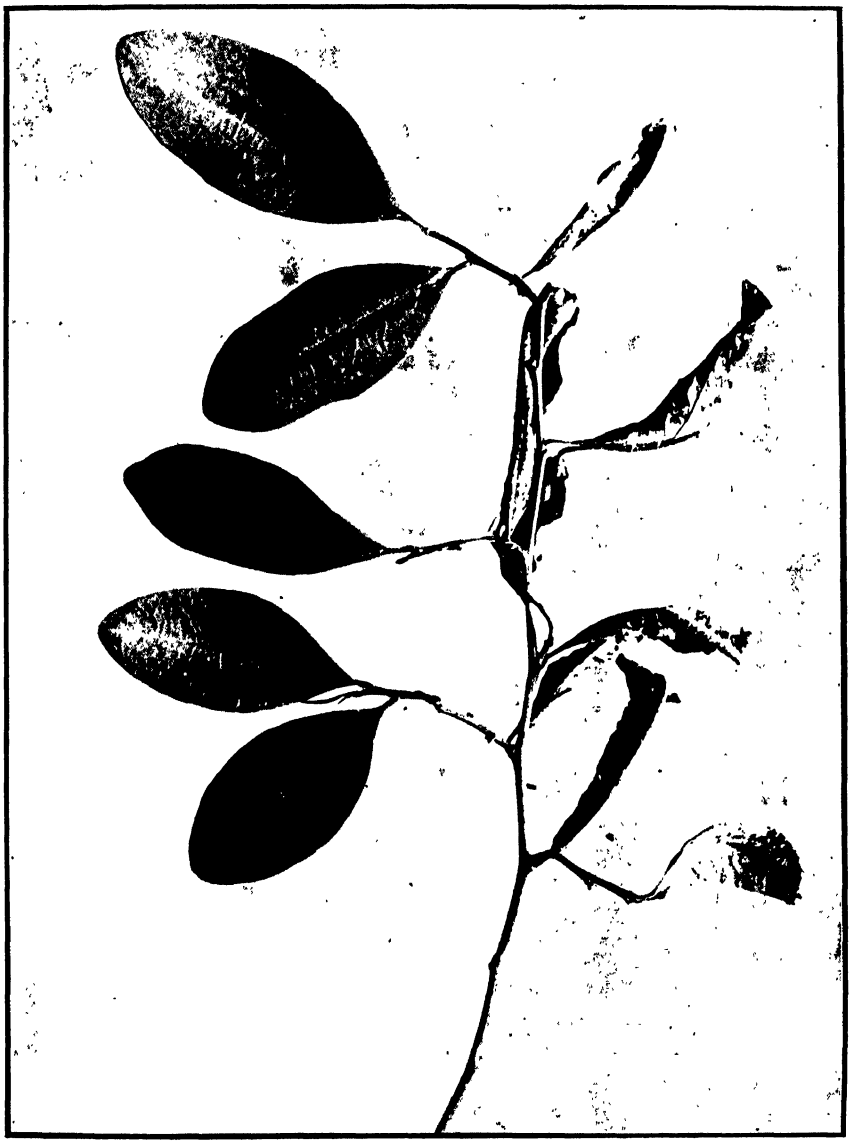

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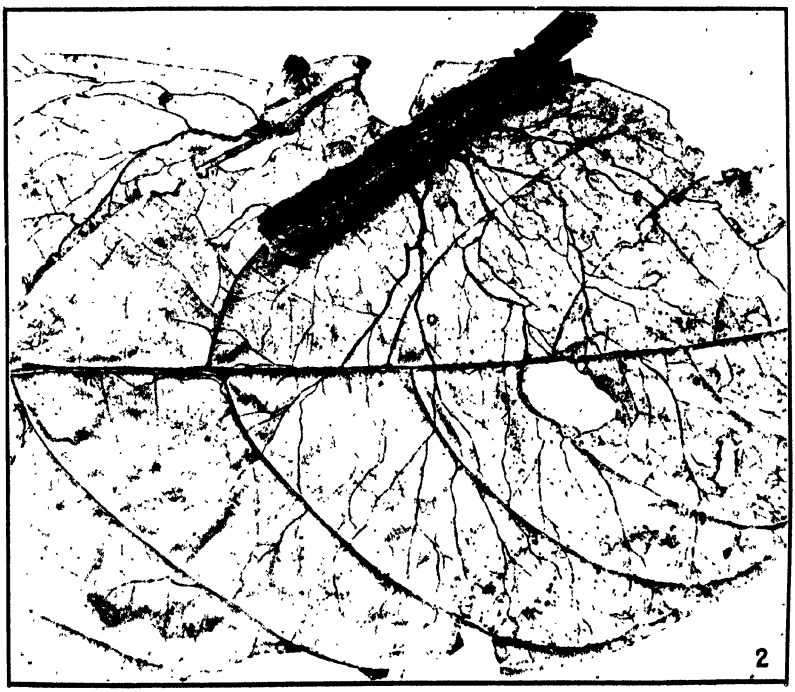

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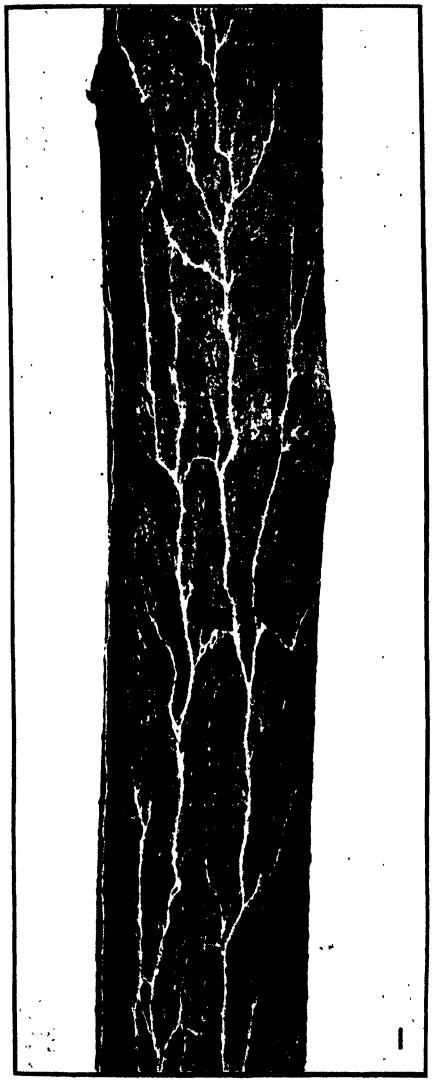

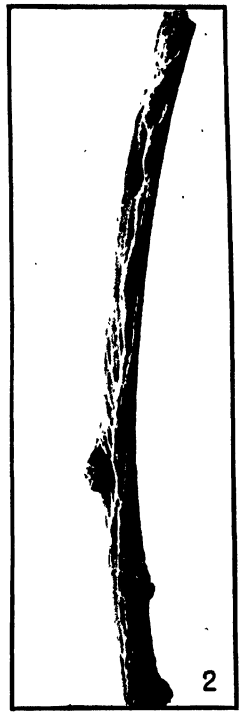

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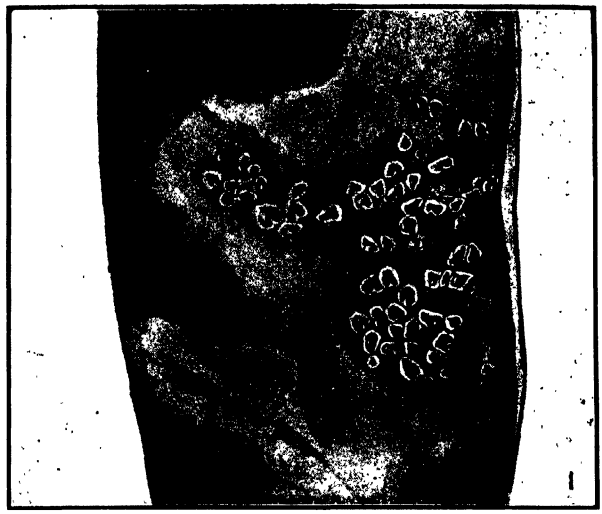

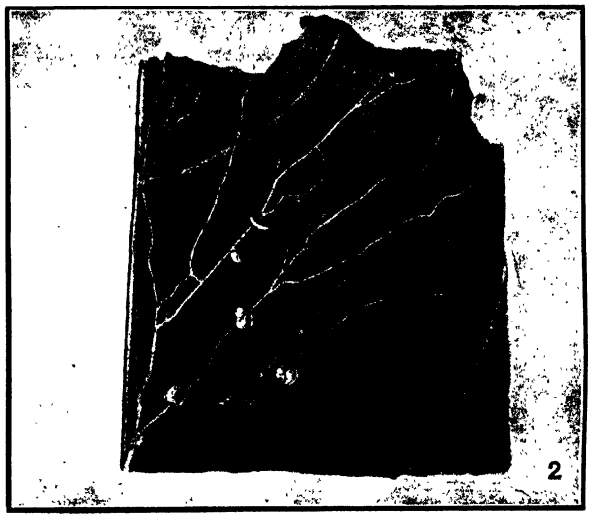

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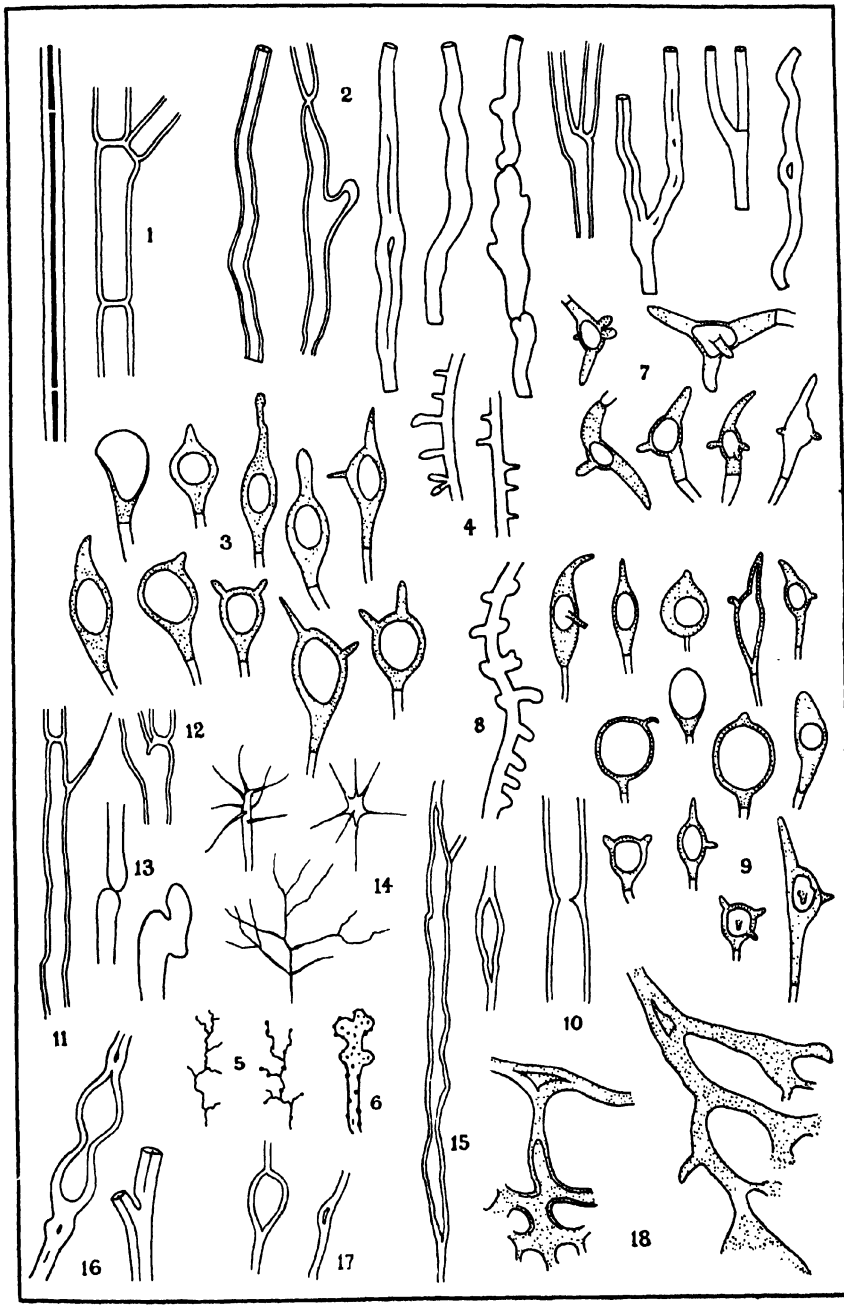

THREAD BLIGHTS.

Phytophthora Faberi Maubl.

BY

C. H. Gadd, B. Sc.

WITH ONE PLATE.

History

Pod rot is one of the oldest and best known diseases of the cacao tree. A quotation of Dr.de Verteuil, given by Rorer (29), indicates that the presence of this disease had been observed in Trinidad as early as 1727. By the end of the nineteenth century, owing to its destructive nature, the disease had attracted attention in all the principal cacao-growing countries of both the East and the West Indies.

In 1899, after an examination of diseased pods from Trinidad, Massee (15) reported the presence of a *Phytophthora* on all the pods sent, and referred it to the species *P. omnivora* de Bary. Later, the fungus was studied by others notably von Faber (32), Rorer (29), and Coleman(9), who expressed doubts as to the correctness of Massee's identification. As a consequence of von Faber's careful morphological study of the fungus, Maublanc (16), in 1909, described it as a new species. He stated "Il est certain que le champignon du Cacaoyer presente des grandes affinités avec le *Phytophthora Cactorum*, mais d'après les récentes observations de von Faber, il parâit bien en être diatinct et nous croyons devoir le considerér comme une espêce speciale sous le nom de *Phytophthora Faberi* nov. sp." It is by this name that the fungus is now universally known

Usually associated with the pod disease of cacao is a disease of the stem, to which the name 'canker' has been applied. Petch (23) was the first to question the parasitism of the various Nectrias and Calonectrias to which the cacao canker had been ascribed in various countries. In 1910, Rorer (29) isolated a *Phytophthora* from cankered bark, and was able by inoculation experiments to prove that the *Phytophthora* which causes cacao pod rot is also the cause of canker, and that the diseased pods serve as the chief source of infection of the tree. Inoculation experiments carried out in Ceylon by Petch (24), confirmed Rorer's

conclusions. It is now generally agreed that the cause of pod rot and canker of cacao in all cacao-growing countries is *P. Faberi*.

Claret-coloured canker and pod rot of *Hevea* first appeared in Ceylon in 1903 (7). Concerning the pod rot of Hevea, Petch (21) in 1905 stated, "The disease is due to a parasitic fungus similar to, if not identical with, hat which causes the decay of cacao pods." In 1910 (24) after a series of inoculation experiments on *Hevea* with *Phytophthora* spores obtained foom cacao, he concluded that "The canker and pod disease of *Hevea* arre both caused by *Phytophthora*, and that the species is the same as that which causes pod disease and canker in Cacao, viz., *Phytophthora Faberi* Maubl." Later (25), (26), he concluded that the leaf fall which often follows the fruit disease, is caused by the canker fungus. Thus in Ceylon, diseases of the fruit, cortex and leaves of *Hevea* are attributed to *P. Faberi*.

Similar conclusions were reached by Rutgers (31) in 1917, after a series of inoculation experiments with *P. Faberi* on *Hevea* in Java. Concerning the virility of *P. Faberi* on *Hevea* pods, he says, "When starting the experiment there was not one diseased fruit in the plantation; after three weeks the experiments had to be stopped because locally 50 per cent of the fruits were attacked, many of them being quite covered with *Phytophthora* conidia." He also demonstrated that the same fungus was a cause of stripe canker, which in Ceylon is known by the name of Bark rot or Black thread.

In 1906, Petch (22) reported a decay of breadfruit due to a *Phytophthora* which he considered to be the same as that on cacao pods and *Hevea* fruits.

In 1916, a *Phytophthora* on papaw fruits (*Carica Papaya*) was reported from the Philippines (20). Microscopic examinations and infection experiments led to the conclusion that, in both the cacao and papaya diseases, *Phytophthora Faberi* is the primary agent. In Ceylon, a similar fungus was isolated from diseased papaw fruits in 1921 (13), and from a cankered lesion at the base of the stem of a papaw tree in 1922. As far as the writer is aware this is the first record of *P. Faberi* attacking papaw stems.

In 1912, Rutgers isolated a *Phytophthora* from the nutmeg tree (*Myristica fragrans*) in Java, and after growing it in pure culture concluded that it was identical with the species on cacao. The presence of a *Phytophthora* on nutmeg had previously been recorded by Zimmermann (34) who identified it as "*Phytophthora* spec. (*Ph. omnivora* de Bary ?)." His description of the fungus suggests that it was identical morphologically with *P. Faberi*.

P. Faberi was isolated from a typical case of bud rot of coconuts by Reinking (27) in 1919. As a result of infection experiments and cultural studies, he concluded that "the fungus causing coconut bud rot is identical with the organism which produces black rot of cacao pods,

canker of cacao, fruit rot and canker of *Hevea* rubber and rot of papaya fruit."

Phytophthoras, similar morphologically to *P. Faberi*, have been isolated by the writer from *Dendrobium Maccarthiae* and *Odontadenia speciosa*. In both cases, the plants had been growing in a garden surrounded by rubber trees severely affected by pod rot and leaf fall. The orchid had wilted and died suddenly as a result of the fungus having established itself in the stem. The leaves, flowers and buds of *Odontadenia* were attacked, and the shoots died back rapidly. The prevalence of the *Phytophthora* on *Hevea* at the time suggested that infection had come from that source. Inoculation experiments showed that the strains isolated from *Dendrobium* and *Odontadenia* readily attacked *Hevea* pods, and it was concluded that they were of the same species as that occurring on *Hevea*.

In addition to the above enumerated hosts on which *P. Faberi* occurs in nature, the fungus has been successfully inoculated on to numerous other plants by Coleman, Reinking, and others. The omnivorous habit of this fungus is therefore evident, and it must be regarded as one of the most destructive known.

Scope of Investigations

As no definite criteria for the identification and separation of the species belonging to the genus *Phytophthora* are known, considerable reliance has to be placed on the mode of development and size of the oospores, the measurements of sporangia and chlamydospores, and the results of cross inoculation experiments. The arrangement of the sexual organs and the size of the oospore have been found to be the best character on which to base the natural separation of species. In the absence of oospores, the delimitation of species becomes more difficult owing to the great variability in size of the sporangia and chlamydospores. Oospores of *P. Faberi* have not been found in nature, nor obtained in pure culture; consequently considerable reliance has been placed on general morphological characters and on inoculation experiments, for the determination of this species.

Concerning the validity of cross inoculation experiments in delimiting species of *Phytophthora*, Wilson (33) states:—"A comparison of the results published by various authors tends to throw decided doubt on the value of this method of delimiting species in this genus, as practically any species of *Spermatophyta*, which is in nature subject to the attack of any *Phytophthora*, is likely under laboratory conditions to be more or less severely attacked by almost any other species." The use of certain

morphological characters alone is liable to equally strong objections owing to their variable nature.

On the publication of Reinking's investigations on the cause of coconut bud rot in the Philippines, Butler (5) drew attention to the possible identity of *P. Faberi* with *P. palmivora*, which had previously been demonstrated to be the cause of bud rot of Palmyra and coconut palms in India (4).

In Jamaica, Ashby (1), (2), isolated from coconut palms affected by bud rot, a species of *Phytophthora* which Butler, from cultures sent to him, identified as *P. palmivora*. Ashby's comparison of pure cultures of the cacao and coconut Phytophthoras showed that the macroscopic growth and microscopic characters of the mycelium, the size and shape of the sporangia, and the size of the resting spores (chlamydospores) were all very much alike, though minor differences were observed. His inoculation experiments, however, indicate that the cacao *Phytophthora* does not readily attack the coconut, and that cacao pods cannot be rotted by the form from the bud rot of the coconut. In a later publication (3), he concluded that the Phytophthoras from coconut and cacao must be regarded as distinct species, viz. *P. palmivora* and *P. Faberi* respectively, and not as different biological varieties of one species.

The *Phytophthora* diseases of *Hevea* in South India are caused by *P. Meadii*, a species which differs from *P. Faberi* in that it produces oospores in nature and in pure culture. Both the sporangia and the chlamydospores of *P. Meadii* are similar in shape and size to those of *P. Faberi*; in the absence of oospores, therefore, it is a difficult matter to distinguish the two species morphologically. The *Phytophthora* which causes similar diseases of *Hevea* in Burma has been identified by McRae (19) as *P. Meadii*, though in Burma it does not produce oospores.

It is thus evident that at least two species, with morphological characters similar to those of *P. Faberi*, are normally found on plants which are known to have been successfully inoculated with pure cultures of *P. Faberi*. As the Phytophthoras occurring on several different hosts in Ceylon have been referred to one species, viz. *P. Faberi*, it appeared advisable to make a comparative study of these strains to determine whether they are morphologically and physiologically identical. With that object in view, isolations were made of the Phytophthoras from diseased cacao pods, rubber pods, papaw fruit, papaw stem, breadfruit, *Dendrobium*, and *Odontadenia*, and the different strains grown in pure culture.

All cultures were started from single sporangia which had germinated as simple conidia. The sporangia were obtained either direct from the diseased tissues, or from cultures derived from diseased tissue. Dilution

plates were poured with bean agar, though maize-meal agar was generally used for tube cultures.

The cultures were grown in tubes at room temperature. The maximum and minimum temperatures recorded in the laboratory in which the cultures were grown. were 29°C and 22°C respectively. These temperatures were recorded during the hot season. Normally the temperature varied between 24°C and 27°C.

Growth on Culture Media

Maize-meal agar. All strains make good growth on maize-meal agar, and produce abundant, white, flocculent aerial mycelia. The development of aerial mycelium varies somewhat in different cultures, owing probably to differences in the hardness of the media and in the moisture content. In general, however, the aerial growth is greatest in cultures of the fungus from papaw stem.

Sporangia begin to be formed at the end of the second day. The strains from breadfruit, rubber, *Dendrobium*, and cacao produce sporangia more freely than do the strains from *Odontadenia* and papaw. In five-day old cultures of the former fungi, the mycelia have a powdery appearance, owing to the abundant development of sporangia, but in the latter cultures the sporangia are not so evident.

Chlamydospores are produced most abundantly in cultures of the cacao *Phytophthora*. In cultures of the breadfruit, rubber, *Dendrobium*, and *Odontadenia* strains, very few chlamydospores are produced in proportion to the number of sporangia, though some may be found in all cultures. In both the strains from papaw, sporangia and chlamydospores occur in almost equal proportions, and in this respect these strains resemble the cacao fungus.

The mycelia of all strains are similar, and typical of the genus *Phytophthora*. When young, the hyphae are non-septate and filled with dense granular protoplasm. In old cultures septation is more frequent. Transverse walls occur mainly to cut off the reproductive organs, and to separate empty sections of hyphae from those containing protoplasm. The aerial hyphae are more regular than the submerged hyphae, which have a somewhat warty or gnarled appearance. The diameter of the hyphae varies from 2-7 μ.

Bean agar. On this medium the growth is more submerged, and less aerial mycelia is produced. As on maize-meal agar, aerial mycelium is developed most abundantly by the strain from papaw stem, and to a lesser extent by that from papaw fruit. The strains from rubber, *Dendrobium*, breadfruit, and cacao give very little aerial growth, while that from *Odontadenia* is very variable ; in some cultures of the last the

aerial growth is as abundant as that of the papaw fruit strain, while in others very little is produced.

The submerged hyphae in bean agar have a more gnarled or tuberculate appearance than is common in cultures grown on maize-meal agar. Though the growth is good on this medium, it is not so rapid as that on maize-meal agar.

Spores are formed abundantly by the cacao, rubber, *Dendrobium*, and breadfruit strains on the surface of the agar, which consequently has a roughened or warted appearance. As on maize-meal agar, spore production is less in the *Odontadenia* strain and least in the two strains from papaw. Chlamydospores are not so freely produced by the cacao and papaw fungi as on maize-meal agar, and they are formed some few days after the sporangia have appeared. Few chlamydospores are to be found in cultures of the other strains on this medium.

Sporangiophores

The development of the sporangiophores may readily be observed in cultures grown on films of nutrient agar in Van Tieghem cells. The sporophores are not readily distinguished from ordinary hyphae except by the presence of sporangia. The sporangia are usually produced at the ends of the sporophores. The growth of a sporophore is, however, continued by a branch arising just below the previously-formed sporangium, and this in turn forms another at its tip. Continued sympodial branching results in the formation of numerous sporangia on what appears to be an unbranched sporophore.

The number of sporangia found on a single sporangiophore varies from 1 to 20. Some strains are more prolific of sporangia than others, the strains from rubber, breadfruit, and *Dendrobium* being the most productive, and those from papaw and *Odontadenia* the least. The latter fungi produce fewer sporangiophores. These facts would account for the comparative paucity of sporangia found in tube cultures of these strains.

The formation of lateral branches is rare in all strains. Usually the sporophores appear unbranched, and rarely are more than two branches to be found. Coleman's observations (9), however, indicate that the complexity of the sporangiophores of *P. Faberi* is very variable ; in some cultures the sporangiophores may be quite as complicated as those described for *P. omnivora*, though usually they are small and bear few sporangia. The complexity of the sporangiophores, therefore, must be used with the greatest caution for taxonomic purposes.

The length of the sporangiophores varies from 30-250 μ and the diameter from 2-5 μ in cultures grown in Van Tieghem cells on maize-meal

agar. In tube cultures the variation appears to be greater, but it is impossible to get accurate measurements owing to the tangled nature of the mycelium.

Usually the sporangiophores are regular and uniform, but in some cases they are inflated at various points into large or small swellings. Small swellings at the point of insertion of the sporangia are found frequently in cultures of the rubber and breadfruit Phytophthoras grown in Van Tieghem cells, but similarly swollen sporangiophores were rarely found in tube cultures. In some cases the end of a hypha swells as though a sporangium were about to be formed; then the swelling ceases to increase, and three or four lateral branches are produced, which either form sporangia or continue as ordinary hyphae.

No distinctive characters of the sporangiophores were observed, by which the various strains could be readily separated from one another.

Sporangia.

The sporangia are normally produced on sporangiophores, but occasionally they are intercalary.

They are mostly pear-shaped, and attached to the sporangiophore at the blunt end. They may be narrowly or broadly ovate, or elliptical, and in some cases almost spherical. When grown on maize-meal agar, the sporangia of the cacao and papaw strains are, on the average, more broadly ovate than those of the other strains. In other respects the general appearance and structure of the sporangia of all the strains are alike.

At the apex, or narrow end, of the sporangium is a prominent raised papilla. Occasionally, sporangia with two papillae are seen, but these are obviously abnormal. The wall is thin, smooth, and colourless; the contents, finely granular, usually with a central vacuole. The wall at the base of the sporangium is usually thickened by a cellulose deposit on the inner surface. Frequently this deposit is represented only by a small plug or projection, situated immediately opposite the point of insertion. Old sporangia may have the whole of the inner surface of the sporangial wall covered by an even deposit of cellulose, resulting in a thickening of the wall similar to that common in chlamydospores. Occasionally the cellulose is deposited as small columns which project into the interior of the spore. Secondary thickening of the sporangium wall, other than a small deposit at the base in the shape of a small plug, is, however, rare, but some examples may be found in most old cultures. The presence of the cellulose plug is fairly constant, though in some sporangia it is better developed than in others, while in some it is entirely absent. Similar plugs have been reported by Butler and Kulkarni (6) for *P.*

Colocasiae, and by McRae (19) for *P. Faberi* and *P. Meadii*. According to McRae, the plugs are more frequently found in *P. Faberi* than in *P. Meadii*. The plugs found in these strains are, however, not usually so strongly developed as those figured for *P. Colocasiae*.

The sporangia usually fall off their sporangiophores with a short pedicel or vestige of the stalk attached. These pedicels rarely exceed 6 μ in length. The adhesion of a portion of the sporangiophore would not appear to be accidental. as the point at which abscission will occur may clearly be distinguished on many sporangiophores. Similar pedicels have been recorded by Butler and Kulkarni for *P. Colocasiae*, and observed by Zimmermann (34) in his *Phytophthora* from nutmeg.

Germination. Sporangia germinate either by zoospores or by germ tubes. No differences were observed between the various strains as to the size or number of zoospores formed in a sporangium nor in the mode of production of germ tubes.

Zoospores begin to emerge about 15 minutes after the sporangia are placed in water under suitable conditions. The number emitted from a single sporangium varies with its size ; the larger sporangia as a rule produce the greater number of swarm spores. The maximum seen to emerge was 26. The swarm spores are biciliate and vary in size from 7μ to 11μ. They swim about vigorously for some time, then come to rest, round themselves off and germinate by single germ tubes. If, as sometimes happens, the zoospores fail to escape from the sporangium, the germ tubes which originate from them penetrate the sporangium wall at various places and continue their normal growth. The germ tubes of those zoospores which come to rest near the dissolved papilla, usually emerge through that aperture

When a sporangium germinates as a simple condium, it gives rise to one or more germ tubes. These may originate at any part of the sporangium wall, but when only one tube is produced, it usually arises from the base or side of the papilla. When germination occurs on a substratum rich in food material, the germ tubes continue their vegetative growth and give rise to a branched mycelium. In the absence of a plentiful food supply the germ tubes, after a short growth, form small sporangia at their tips. These secondary sporangia may germinate either by zoospores, or by germ tubes which in their turn may form tertiary sporangia. In old cultures such chains of sporangia may frequently be seen.

Environmental conditions determine to a large extent the method of germination. If a suspension of sporangia is made in fresh tap water, the water, after half an hour, will contain a large number of actively swimming zoospores. After two and a half hours no active zoospores will be present, though many mature sporangia have not germinated.

The majority of these germinate later as ordinary conidia. The proportion of sporangia which discharge their contents as swarm spores varies with the environmental conditions.

The main factors affecting the formation of zoospores are temperature, light, and air. The optimum temperature for the strains used in these investigations lies between 20° and 25°C ; temperatures below 20° and above 25° retard zoospore formation. More sporangia discharge their contents when the suspension is well illuminated than when placed in the dark. Swarming, however, does occur in the absence of light, and it would appear that light is not as important a factor of zoospore formation in these strains as has been shown to be the case for *P. Arecae* (9) or *P. parasitica* (10)

The importance of a suitable air supply as a factor influencing the emission of zoospores has not generally been recognised. When measuring sporangia mounted in water, it was noticed that very few discharged zoospores, although conditions appeared to be suitable. When swarming was observed, it occurred from sporangia near the edge of the coverglass or in close proximity to air bubbles. This suggested the necessity of a requisite air supply. Subsequently, suspensions of sporangia were made in water which had been boiled and allowed to cool. Swarming, however, did not occur in such suspensions. Also it was ascertained that in suspensions which are vigorously shaken in order to entrap air, more sporangia germinate by means of zoospores than in similar suspensions not shaken. The difficulty experienced by various investigators in obtaining zoospores at will, is possibly connected with the oxygen requirement of the species. In this connection, Klebahn's observations (14) on *P. Syringae* are of interest. Sporangia of this species were formed in water cultures, but they would not discharge zoospores unless they were placed in water well saturated with oxygen.

Chlamydospores

When working with *P. Faberi*, von Faber, Coleman and Rorer observed spherical bodies which they considered to be oospores. Neither von Faber nor Coleman observed antheridia, and von Faber failed to find oogonia also. Coleman explains the latter failure on the ground that the oospores " always fill the oogonial cavity so completely that the oogonial wall can be made out only with difficulty." Later writers have shown that these are multinucleate vegetative bodies serving the same function that chlamydospores serve in other groups of fungi. They are, therefore, not parthenogenetic oospores as stated by Coleman, but chlamydospores or " resting " conidia.

Chlamydospores were found in cultures of all strains on maize-meal

agar, and were more freely produced by the strains from cacao and papaw than by the others. Their formation depends to a large extent on external conditions, as it is well known that the production of chlamydospores is much greater on some media than on others. The absence of light, which is detrimental to sporangia development, favours the production of chlamydospores. Cultures of the strains from breadfruit, rubber and *Dendrobium*, which normally produce few chlamydospores, develop them more freely when grown in the dark.

The chlamydospores are formed either terminally or intercalarily in both the aerial and submerged mycelia. They are spherical, with smooth, thin or thick walls, and are filled with dense granular protoplasm. When first formed the walls are thin and colourless, but later they become thickened and sometimes yellow. In some cases, the wall becomes 3-4 μ thick owing to the deposit of cellulose on the inner surface, while in others the wall remains comparatively thin. Usually, the cellulose is evenly deposited, so that the inner surface of the wall remains smooth, but occasionally chlamydospores are found with small columns of cellulose projecting into the cavity of the spore.

The chlamydospores of *P. Faberi*, formed within the tissue of the cacao pod, usually have thicker walls and are more often coloured than those found in the surface mycelium. It would appear from Rorer's description that he designated the thick-walled form as oospores, and the thin-walled as chlamydospores. He states that chlamydospores "are formed much as are the conidia already described but are spherical." "Almost simultaneously with this superficial spore production oospores are formed within the tissues of the pod." He gives measurements of 30-50 μ for chlamydospores and 33-40 μ for oospores. The diameter of 200 chlamydospores with thin walls, obtained from the surface mycelium of the cacao strain grown on cacao pods, varied from 25-55 μ, the mean being 37.32 ±0.234 μ whereas thick-walled, yellow to yellow-brown spores from the tissue of the pod varied from 23-50 μ in diameter, the mean being 37.02 ±0.256 μ. There is, therefore, no real difference in size between the two forms. Owing to the structure of the spore wall, the thick-walled form might be mistaken for an oospore completely filling the oogonial cavity with the two walls in direct contact. There is little doubt, however, that the two forms are identical, except for the thickness of the wall, and that both are chlamydospores.

Germination. Though frequently termed "resting" conidia, chlamydospores do not require a period of rest before germination. When placed in water, they germinate readily within 48 hours, by means of one or more germ tubes which are frequently swollen at the base. These germ tubes give rise either to a richly branched mycelium, or to sporangia

resembling the secondary sporangia produced by germinating conidia. Secondary sporangia are more frequently formed when the chlamydospores are germinated in distilled water, than when a supply of food material is available for the developing mycelium.

Chlamydospores from dried-out cultures will not germinate, but spores from old,though still moist, cultures germinate readily. Moisture, therefore, appears essential for the retention of the vitality of these spores. It is, however, of interest that Rosenbaum(30) experienced considerable difficulty in inducing chlamydospores to germinate, and that he was successful only after wintering pure cultures.

Though germination is normally by germ tubes, it may also occur by means of swarm spores. In a few instances, swarm spores have been observed swimming vigorously within chlamydospores, though I have never seen them escape. That they do sometimes find their way out is evidenced by the presence of empty chlamydospores in old cultures. They appear to escape through a circular aperture in the spore wall, which is formed at a place where the wall has not been thickened. When the zoospores do not escape, they give rise to germ tubes, which penetrate the chlamydospore wall in the same way as the wall of an ordinary sporangium is penetrated by germ tubes arising from swarm spores which have germinated *in situ*.

From the literature on the subject, it would appear that zoospore formation in chlamydospores has rarely been observed, and that the normal germination is by germ tubes. Maublanc, (17) however, states concerning chlamydospores, " La germination se fait de facon analogue á celles des conidies," from which it would appear that, under certain conditions, zoospore formation may be the common method of germination.

Nature of chlamydospores. In some cultures, particularly those of the cacao strain grown in the dark, spherical bodies resembling chlamydospores are frequently observed. These bodies differ from the normal chlamydospores in having a prominent papilla, and in this respect they resemble sporangia. They represent what might be regarded as an intermediate stage between a sporangium and a chlamydospore. It is probable, therefore, that chlamydospores are modified sporangia. This view is supported, not only by the presence of intermediate bodies, but also by the fact that chlamydospores occasionally germinate by means of swarm spores. The formation of chlamydospores is in many respects similar to that of sporangia, though chlamydospores are rarely formed in "heads." Moreover, the wall of an ordinary sporangium is frequently thickened by a deposit of cellulose at the base, and in a few instances old sporangia have walls as thick as those of chlamydospores.

Chlamydospores may therefore be regarded as modified sporangia. The change in shape of the sporangium,from ovate to spherical, and the loss of the papilla, are accompanied by a change in function. Sporangia are always produced on the surface of the substratum and are well suited for dispersal during wet weather. They, however, cannot withstand dry conditions. Chlamydospores are generally produced within the substratum, though they are also to be found in the surface mycelium, and they are better adapted to withstand dry conditions. Thus they enable the fungus to tide over spells of adverse climatic conditions.

Measurement of Spores.

Owing to the paucity of distinguishing characters in many fungi. great importance has become attached to spore measurements for the delimitation of species. As the spores of any one species vary in size to some extent the dimensions are usually expressed by the limits of variation. This method, though convenient when the range of variation is small, is apt to be misleading when spore forms vary greatly in size. Since very large and very small values are infrequent, the observation of one exceptional individual may alter the range to a greater or lesser extent in either direction.

The spore measurements of *P. Faberi*, as given by various writers, are shown below.—

Authority	Sporangia	Chlamydospores
	μ	μ
von Faber	30-80 × 25-42	45
Rorer	30-60 × 21-30	30-50
Coleman	———	22-45
McRae	34-70 × 16-36	26-46 × 23-43 (average 35.3 × 35)
Maublanc (17)	30-65 × 20-53	30-60

These measurements, except where the average is stated, give no idea of the most prevalent size of the spore forms, which for purposes of comparison is of more value than the dimensions of the largest and smallest spores observed. Owing to the great variation in size of the spores, the limiting measurements are so widely separated, that it is possible that more than one species might be included within these limits, and yet remain indistinguishable by this method of recording spore measurements.

The use of more refined biometrical methods for defining spore dimensions would facilitate comparisons and assist in establishing morphological differences. Rosenbaum(30) has demonstrated the value of statistical methods as a means of delineating species of *Phytophthora*,

and his work suggested that similar methods would afford a ready means of differentiating between the various strains used in these investigations, should definite morphological differences occur.

If the measurements of a number of spores are classified according to their magnitude, it is a simple matter to construct a graph to represent their frequency distribution, and that will convey the general run of the observations to the eye better than a column of figures. In fig. 2, such curves have been constructed from the measurements of the diameters of 200 chlamydospores of each of the strains from rubber, papaw fruit and cacao. It is evident from these curves that the chlamydospores of the rubber strain are, in general, somewhat smaller than those of the strains from papaw fruit or cacao ; also, though the distributions of the papaw fruit and cacao strains centre round the same value (39 μ), they differ in their range of variation, the cacao strain being the more variable,

Though frequency curves tend to make long series comprehensible. and assist in making comparisons between different series of measurements, they are inconvenient for general purposes, as they enable only qualitative or verbal comparisons to be made. There are, however, three fundamental characters in which frequency distributions differ. They may differ in (1) position, (2) range of variation and (3) degree of asymmetry. Of these the first two are the most important. The use of measures which express these characters quantitatively affords a convenient method of defining the size and degree of variation of spore forms. They also enable comparisons between different series of measurements to be made readily.

The mean, together with its probable error, has been used in these investigations as the basis for comparison of spore measurements of the different strains. In the comparison of two statistical results, the difference between the two results, compared with its probable error, is of great importance. If the difference is more than five times greater than its probable error, it may justifiably be considered as significant of a real difference existing between the two results, as the probability of its having arisen as a result of random sampling is small. This standard has been used throughout to determine the significance of observed differences, differences less than five times as great as their probable errors being attributed to errors of sampling.

Statistical methods have been used not only to express the actual measurements of length and width of sporangia, but also to give some quantitative expression of their shape. The ratio of the length to the width of a sporangium expresses quantitatively what is usually stated

qualitatively by the terms elliptical, ovate and globose. If the ratio of the long and short diameters of each sporangium measured is determined, the mean of these determinations becomes a fair measure of the shape of the sporangium. By the use of such methods, the shapes of sporangia may be compared as readily as their dimensions.

Method of measurement.—At first, spore measurements were made to the nearest micron by means of 1.8 mm. oil immersion objective and an eyepiece micrometer. The risk of measuring the same spores twice was avoided by the systematic use of a travelling stage. The measurements so made were then grouped into 2 μ classes to facilitate the calculation of the mean and standard deviation. It was found, however, that when the calculations were based on a grouping in which the classes differed by 4 μ instead of 2 μ intervals, the results were but slightly affected. This may be seen from Table 1, in which are given biometric constants calculated from two sets of measurements, each of which were grouped into 2 μ and 4 μ classes. Measurements A refer to 200 sporangia of the cacao fungus grown on cacao pod; measurements B are of a similar number of sporangia of the same fungus cultured on rubber pods.

Table 1.

The effect on the calculated mean, median, etc., of grouping measurements into classes with 2 μ and 4 μ intervals.

Measurements	Class interval. μ	Mean μ	Median μ	Mode μ	Standard deviation. μ	Skewness
Length of Conidia						
A	2 μ	45.52±.384	45.71	46.09	8.05±.271	—.071±.058
A.	4 μ	45.54±.388	45.77	46.23	8.14±.274	—.085±.058
Difference		.02±.546	0.6	.14	.09±.385	.014±.082
B	2 μ	42.10±.284	42.04	41.92	5.97±.201	.030±.058
B	4 μ	42.14±.287	42.20	42.32	6.02±.203	—.030±.058
Difference		.04±.378	.16	.40	.05±.286	.06±.082
Width of Conidia						
A	2 μ	27.62±.112	27.49	27.23	2.35±.079	.166±.058
A	4 μ	27.60±.107	27.61	27.63	2.34±.079	.013±.058
Difference		.02±.115	.12	.40	.01±.112	.153±.082
B	2 μ	25.52±.142	25.41	25.19	2.99±.101	.110± 058
B	4 μ	25.42±.151	25.38	25.30	3.17±.107	.038±.058
Difference		.10±.210	.03	.11	.18±.147	.072±.082

The effect of the grouping on the resulting calculations is evidently very small, as is shown by the size of the differences, in comparison with their probable errors. It would, therefore, appear immaterial whether the grouping is made by 2 μ or by 4 μ classes. Where the measurements are grouped into classes, all measurements ranging between the limits of a class are considered to be of equal value, that value being represented by the mid-point of the class. For instance, where the grouping is by 4 μ classes, all measurements ranging between 37.50 μ and 41.49 μ are considered to be equal, their value being 39.5μ. the mid-point of the class. If, therefore, a sporangium, 38 μ long, may be regarded as equal in length to others which measure 39, 40, or 41 μ, without seriously affecting the resulting calculations, it is improbable that slight errors in measurement are of great importance, so long as they do not all occur in the same direction.

The measurement of a large number of sporangia by means of an oil immersion lens is a slow and tedious business. As these investigations necessitated the measurement of numerous spores, it appeared advisable to determine whether the use of a lower power objective, and the consequent decreased accuracy of measurement, would vitiate the value of the constants calculated from measurements so made. A test was made by measuring sporangia of the *Dendrobium* strain grown on maize-meal agar, first by means of a 4 mm. objective (one square of the eyepiece micrometer representing 16 μ) and then with a 1.8 mm. oil immersion lens (one square of the eyepiece micrometer representing 6 μ). Altogether 131 sporangia were thus measured. The constants calculated from each set of measurements are given in Table 2 for comparison. For these calculations, the measurements of length and width were grouped into 2 μ classes.

Table 2.

Comparison of constants calculated from measurements made by means of objectives of different magnification.

Length of Conidia.

Objective.	Mean. μ	Median μ	Mode μ	Standard deviation. μ	Skewness
1.8mm.	51.69±.508	51.28	50.46	8.62±.359	.143±.072
4mm.	51.67±.506	51.50	50.86	8.58±.349	.092±.072
Difference	.02±.717	.22	.40	.04±.501	.051±.10

Width.

Objective.	Mean. μ	Median. μ	Mode. μ	Standard deviation. μ	Skewness.
1.8 mm.	28.74±.204	28.61	28.35	3.47±.145	.112±.072
4 mm.	28.57±.210	28.42	28.12	3.56±.148	.126±.072
Difference	.17±.293	.19	.23	.09±.207	.014±.102

Ratio of length to width.

1.8 mm.	1.82±.017	1.83	1.85	.295±.012	—.102±.072
4 mm.	1.82±.018	1.82	1.82	.301±.013	.000±.072
Difference	0.±.025	.01	.03	.006±.018	.102±.102

It will be seen that the differences between the constants, calculated from the measurements made with the different objectives, are so small as to be negligible for practical purposes. Measurements made with the aid of a 4 mm. objective are undoubtedly more liable to error than those obtained with a more powerful oil immersion objective. The errors resulting from the use of an objective of lower power, however, tend to neutralise or offset each other, as, where a large number of spores are measured, it is probable that as many measurements are too large as are too small. For this reason, the greater errors in measurement resulting from the use of a lower powered objective do not appreciably disturb the mean and other constants.

Tests were also carried out to determine whether 200 spores constituted a representative sample of the population from which they were taken. Two separate samples, each of 200 sporangia, were measured on the same day from the same culture ; the constants were then calculated for each sample and compared. In Table 3 the constants obtained from two such samples of sporangia of the rubber *Phytophthora*, grown on rubber pods, are given for comparison. The measurements were made by means of the 4 mm. objective and were grouped into 2 μ classes.

Table 3.

Measurements of two samples, each of 200 conidia, taken from the same culture.

Length.

Sample	Mean. μ.	Median μ	Mode μ	Standard deviation. μ	Skewness.
A	39.55±.332	38.96	37.78	6.97±.235	—.254±.058
B.	39.61±.368	39.02	37.84	7.70±.259	—.230±.058
Difference	.06±.496	.06	.06	.73±.350	.024±.082

Width.

A	24.01±.127	38.80	23.38	2.66±.090	—.237±.058
B.	24.52±.139	24.20	23.56	2.91±.098	—.330±.058
Difference	.51±.187	.40	.18	.25±.133	—.093±.082

Ratio, length to width.

A.	1.65±.010	1.61	1.53	.219±.074	—.552±.058
B.	1.62±.011	1.61	1.59	.239±.081	—.125±.058
Difference	.03±.015	0	.06	.02±.110	.427±.082

These tests indicate that 200 sporangia constitute a representative sample of the population from which they are taken. This was adopted as the normal size of a sample, and all biometric measures given here, unless otherwise stated, are based on the measurements obtained from 200 spores. The measurements were made by means of a 4 mm. objective and an eyepiece micrometer, and were grouped into 2 μ classes to facilitate calculations.

Effect of environment on spore dimensions.

During the progress of these investigations, it became evident that the mean measurements of the spore-forms of a strain are not constant, but vary according to the conditions under which the cultures are

grown. Very rarely are identical measurements obtained from different cultures of any strain, even when grown on the same medium, if the environmental conditions are varied.

The age of a culture at the time sporangia are measured is of primary importance. With the increasing age of a culture various abnormalities, particularly secondary sporangia, become more prevalent. As secondary sporangia are usually smaller than the primary sporangia from which they are derived, any increase in the proportion of secondary sporangia results in a corresponding diminution of the mean measurements. Consequently measurements of sporangia made from old cultures are, on the average, smaller than those from young cultures. Measurements of sporangia are therefore best made at the time when they first make their appearance and before secondary sporangia are formed.

When chlamydospores are measured, the age of the culture is not so important, as there is no marked increase or diminution of their mean diameter with increasing age. The mean diameter obtained from measurements of a culture three months old is approximately the same as that of a young culture with fully developed chlamydospores.

It is well known that species of *Phytophthora* produce different spore forms on different media. On sterilised potato, *P. Faberi* produces chlamydospores in abundance and very few sporangia ; on bean agar, sporangia predominate and chlamydospores are rare. As the nature of the substratum exerts a large influence on the type of spore produced, it may be expected that it will influence the size of the spores also. It may be seen from Table 1 that the measurements of sporangia of the same strain, when grown on cacao pods (A) are greater than those obtained when the fungus is grown on rubber pods (B). The size of the chlamydospores is also influenced by the medium on which they are grown ; e.g., the strain from rubber produces somewhat larger chlamydospores when cultured on cacao pods than when grown on rubber pods. Though none of these strains produces oospores in pure culture, it is of interest to note that the size of these bodies may also be influenced by the substratum. Dastur (12) records that *P. parasitica* from *Vinca rosea* produces smaller oospores on French-bean agar than on oat juice agar.

Small differences, however, occur when measurements are made from cultures growing on apparently similar substrata. Below are given mean measurements of sporangia of the rubber strain, obtained from different cultures grown on maize-meal agar

	Length.	Width	Ratio L/W.
	μ	μ	
(1)	49.37±.390	28.82±.180	1.72±.013
(2)	54.99±.400	30.57±.213	1.80±.013
(3)	47.92±.315	26.45±.162	1.79±.009

These differences may be due to small changes in the chemical constituents, or to varying amounts of moisture in the media. Such differences occur not only with cultures grown on artificial media, but also on natural substrata, as may be seen from the following measurements of sporangia of the rubber strain obtained from different cultures on *Hevea* pods.

	Length	Width.	Ratio L/W
	μ	μ	
(1)	39.55±.332	24.01±.127	1.65±.010
(2)	47.40±.369	27.06±.149	1.76±.011
(3)	44.17±.277	27.30±.116	1.62±.009

Moisture is an essential factor for the formation of sporangia; and from the fact that sporangia produced in tube cultures are frequently larger than those formed in cultures in petri dishes, it would appear that moisture may be an important factor influencing the size of sporangia. The size of chlamydospores, however, is not appreciably affected by varying amounts of moisture.

When grown in the dark, cultures of all the strains under investigation produce very few sporangia on maize-meal agar, but these are, on the average, larger than those produced in cultures grown on the same substratum in the light. The effect of light on the size of sporangia is shown by the following measurements, made from cultures of the rubber strain, grown on maize-meal agar in tubes.

	Mean length.	Mean Width.	Mean ratio L/W
	μ	μ	
In light	47.98±.357	25.42±.153	1.89±.013
In darkness	51.92±.366	27.89±.172	1.87±.013
Difference	3.94±.511	2.47±.230	.02±.018

The tubes were poured from the same stock, and inoculated from the same culture, but one was placed near the window and the other enclosed in a light-tight box near by. The measurements were made when the cultures were four days old. These measurements show that, though the sporangia of the two cultures differ in length and width, yet their shape remains constant.

The size of the chlamydospores is similarly affected by light. The mean diameter of 200 chlamydospores of the cacao fungus, grown on maize-meal agar in the light, was found to be 39.64±.240 μ, whereas that of the chlamydospores of a similar culture grown in the dark was 43.72± .278 μ, the difference being 4.08±.367 μ. This is a significant difference, from which it may be concluded that light influences the size of chlamydospores in the same way as it affects the dimensions of sporangia.

Concerning the effect of temperature, Rosenbaum states that low temperatures tend to diminish the size of spore forms, and higher temperatures to diminish their production. Experiments were not carried out with controlled temperatures during these investigations, but it would appear from a comparison of measurements made from cultures grown at room temperature at various times, that the effect of temperature on the size of the spore forms is not at all marked within the normal range of temperature of the laboratory at Peradeniya.

Owing to the influence of environmental conditions on spore dimensions, measurements must be made from cultures growing under identical conditions if they are to be strictly comparable. Unless the external conditions are very similar, conclusions based on differences between spore measurements of species of *Phytophthora* are likely to be vitiated by the variability of the spore dimensions resulting from the effects of the different conditions.

The value of spore measurements, as a means of delineating species of *Phytophthora*, is considerably diminished owing to the variability of the size of the spores when grown under different environmental conditions. The mean measurements of the spores of any one species are not necessarily the same wherever that species is found, even when it occurs on the same host plant, as any difference in climatic conditions may appreciably affect the dimensions of the spores. Also, where a species attacks more than one host, the spores obtained from one host may differ appreciably in size from those obtained from another, owing to the effect of the different substrata.

Measurements of Sporangia.

In order to obtain comparable measurements of sporangia of the different strains, cultures of each were grown in petri dishes on maize-meal agar. The plates were poured from a common stock, and stood side by side in the laboratory, the temperature of which varied between 23° and 27°C during the period these cultures were under observation. Measurements of the breadfruit, cacao, rubber and *Dendrobium* strains were completed within the first five days, but those of the papaw and *Odontadenia* strains were not completed till the seventh day, as they were

later in producing sporangia. The mean measurements of 200 sporangia from each strain are given in Table 4.

Table 4

Comparable measurements of sporangia from maize-meal agar cultures.

Strain	Mean length μ	Mean width. μ	Mean ratio L/W
Cacao	48.17±.297	34.09±.231	1.42±.006
Papaw fruit	49.84±.336	32.56±.269	1.55±.010
Papaw stem	48.41±.394	32.37±.267	1.56±.011
Rubber	47.92±.315	26.45±.162	1.79±.009
Odontadenia	48.58±.447	26.46±.195	1.84±.011
Dendrobium	49.50±.376	26.53±.123	1.86±.010
Breadfruit	49.59±.310	27.38±.253	1.80±.007

In length the sporangia are alike ; the observed differences between the various strains are not sufficiently marked to warrant the conclusion that they are real, or due to causes other than errors in sampling. As regards their width, however, the strains fall into two distinct groups ; the cacao and papaw strains, having wider sporangia, constitute one group, and the remaining strains the other. The differences in width give rise to differences in the ratios of length to width, by which shape is denoted. There is a significant difference between the length to width ratio of the cacao strain and that of the papaw fruit strain, but the separation of the cacao from the papaw strains is not warranted by other measurements made from cultures on maize-meal agar. On this medium, the sporangia of the rubber, *Odontadenia*, *Dendrobium* and breadfruit strains are consistently more elongate than those of the cacao and papaw strains.

The strains may, therefore, be divided into two distinct groups according to the shape of their sporangia. The cacao and papaw strains are alike in having, on the average, broadly ovate sporangia, and these strains for convenience will be referred to as the cacao group. The other strains with more elongate sporangia constitute a second group, which may be termed the rubber group.

In fig. 1, the frequency distributions of the mean length to width ratios of the papaw fruit and the rubber strains respectively are represented graphically. The frequency distribution for the papaw stem strain is very similar to that of the strain from papaw fruit, but that for the cacao strain is somewhat less dispersed, as may be judged from the probable error of the mean, though the two curves centre about the same

point. The frequency distributions of the *Dendrobium*, *Odontadenia* and breadfruit strains are very similar to that of the rubber strain. The curves given in fig. 1 may therefore be taken as typical of the two groups.

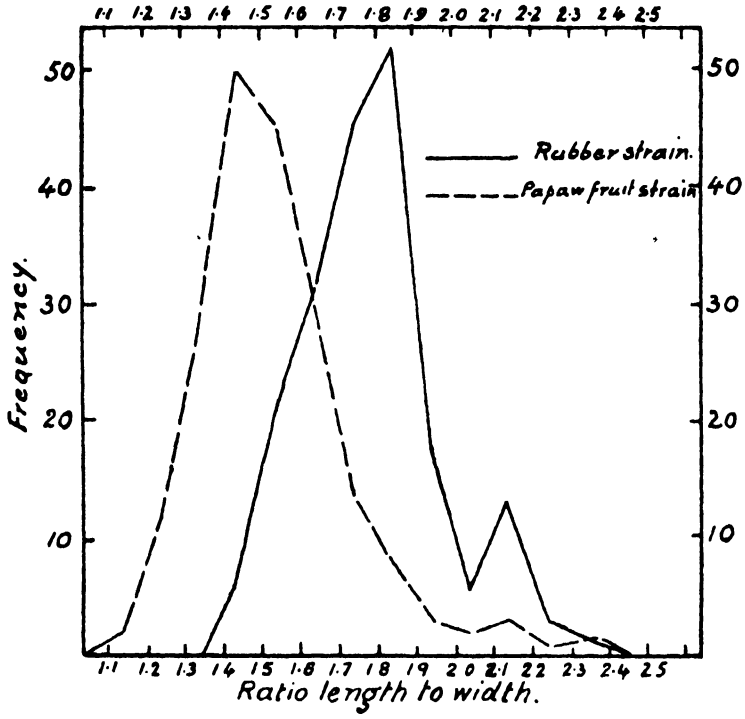

Fig. 1. Frequency distribution of the ratio, length to width of sporangia of the strains from papaw fruit and rubber.

This difference in shape of the sporangia between the two groups, however, is not constant on all media. Measurements made on the rubber and cacao strains grown on rubber pods give mean length to width ratios of 1.65 and 1.62 respectively, the shape thus being practically the same. Again, from measurements made of sporangia on the *Dendrobium* material from which the strain was isolated, a mean ratio of 1.36 was obtained, as against 1.86 on maize-meal agar. Evidently the mean shape of sporangia is influenced to a great extent by the nature of the substratum.

If, for reasons already adduced, chlamydospores are regarded as modified sporangia, it is to be expected that some conditions, such as the nature of the substratum, which favour the production of chlamydospores to the detriment of sporangia, will have some influence on the shape of the sporangia, tending to make them more globose. In this respect it is of interest that the three strains with broadly-ovate sporangia, which form the cacao group, produce chlamydospores more readily on maize-meal agar than do those strains with narrow ovate sporangia, which form the rubber group.

Chlamydospores.

The cultures from which the measurements of chlamydospores, given in Table 5, were obtained, were grown on maize-meal agar in tubes poured from the same stock and placed side by side in the laboratory. The measurements were made during the third week. During this period the room temperature varied from 22° to 26°C.

Table 5.

Comparable measurements of chlamydospores from maize-meal agar cultures.

Strain	Mean μ	Median μ	Mode μ	Standard deviation μ
Cacao	39.63±.317	39.32	38.50	6.64±.224
Papaw fruit	38.89±.190	38.97	39.13	3.98±.134
Papaw stem	38.79±.199	38.97	39.33	4.13±.139
Rubber	35.46±.216	35.71	36.25	4.52±.152
Odontadenia	36.02±.174	36.35	36.65	3.65±.123
Dendrobium	35.11±.254	35.34	35.80	5.33±.179
Breadfruit	35.32±.185	35.39	35.53	3.88±.131

It will be seen, from the mean measurements of the diameter of the chlamydospores, that the strains may again be divided into two groups. The cacao and papaw strains again form one group, and the remaining strains the other. This grouping is identical with that arrived at from measurements of the sporangia.

The chlamydospores of the cacao group are larger than those of the rubber group, the former having a mean diameter of approximately 39 μ, and the latter a mean of 35.5 μ approx. The frequency distributions of the cacao, papaw fruit, and rubber strains are represented graphically in Fig. 2. The curve for the rubber strain is similar to those of the other members of its group, and may be taken to represent the group. The frequency curve for the strain from papaw stem is identical with that

given of the papaw fruit strain. It will be seen, however, that though the curve representing the frequency distribution of the cacao strain centres about the same point as does that of the papaw fruit strain, it is flatter, covers a greater range, and is more dispersed. Though the cacao strain may be distinguished from the papaw strains by the greater variability of the chlamydospores on maize-meal agar, such a differentiation would serve little purpose, and the three strains may, at least for the present, be regarded as forming one group.

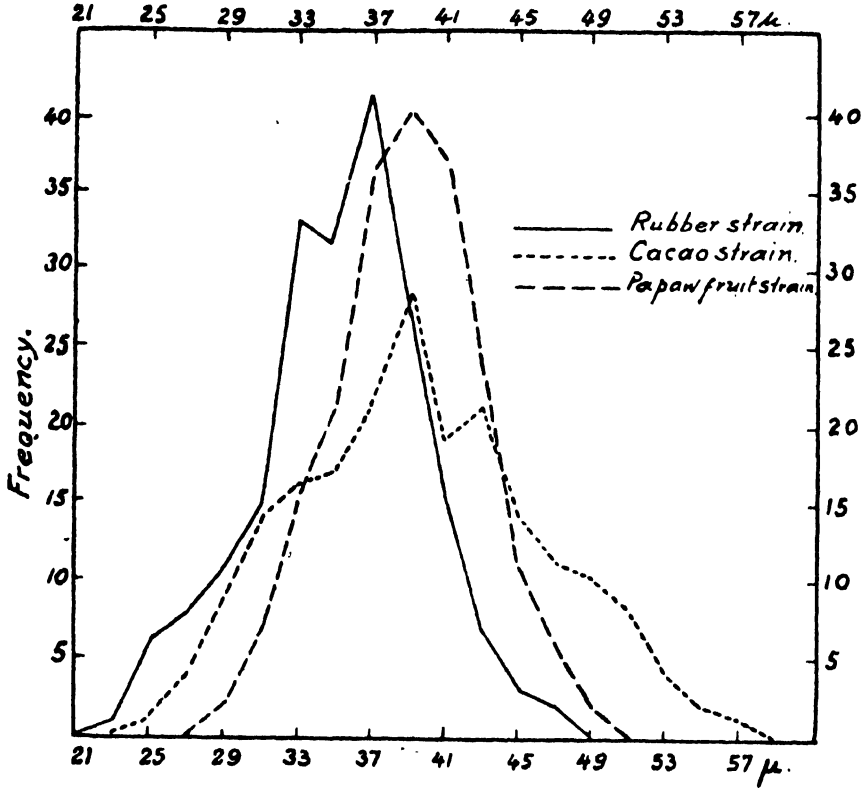

Fig. 2. Frequency distribution of chlamydospore measurements of the strains from cacao, papaw fruit and rubber.

Though the chlamydospores of the cacao group may be distinguished from those of the rubber group, when grown on maize-meal agar, by their greater size, this difference is not constant on other media. On cacao pods, the mean diameter of the chlamydospores of the cacao strain was found

to be 37.02±.256 μ, and that of the rubber strain 37.91±.240 μ. On *Hevea* pods, the mean diameters of these strains are approximately equal, but smaller than those obtained from cultures growing on cacao pods.

It will be evident from the foregoing, that the morphological differences between the cacao and rubber groups, as exhibited by measurements of the spore forms on maize-meal agar, are lost when the cultures are grown on certain other media. Consequently the value of these characters as a means of distinguishing the groups is correspondingly diminished.

OOSPORES.

Oospores were not found in any of the pure cultures, nor in the tissues of the host plants from which the strains were isolated. They were found, however, when certain strains were grown in mixed culture. Mixed cultures, obtained by inoculating maize-meal agar slants with the strains from cacao and *Odontadenia* an inch or so apart, produce sexual bodies abundantly, at first at the line of junction of the two colonies, and later in the zones of both the cacao and the *Odontadenia* fungi.

These sexual bodies are of the *P. infestans* type with persistent amphigynous antheridia.

The oogonia are spherical, with thick, yellow or yellow-brown walls, and vary from 28 to 34 μ in diamater. At times the thick wall is so opaque that it is only with difficulty that the enclosed oospore can be seen. At first the wall is thin and smooth, and has a definite sharp outline, but later, owing to a deposit of secondary thickening, the outer surface of the wall becomes rough and loses its sharp definition. The wall may become as much as 4 μ thick. As a rule, the largest oogonia have the thickest walls as an increase in thickness of the wall results in an increase in diameter of the oogonium. The thickness of the wall, and consequently the diameter of the oogonium itself, depends to some extent on the nature of the substratum. On bean agar the oogonium wall is never so strongly thickened as on maize-meal agar, nor is the smooth distinct outline lost.

The oospores are spherical, smooth and hyaline. They vary in diameter from 21 to 28 μ, and the wall varies from 1 to 2 μ in thickness. The oospore never completely fills the cavity of the oogonium, nor is it ever liberated from the oogonium. Thus the oogonial wall forms an extra, permanent coat for the spore.

The antheridia are hyaline, thin-walled, and remain firmly attached to the base of the oogonium. They vary in length from 10 to 16 μ, and in width from 13 to 17 μ. Usually, the antheridia are empty after the oospores are developed, though they may sometimes contain one or more globules.

As far as could be ascertained, the oogonia and antheridia are always formed on separate hyphae. In many cases, however, it is impossible to trace the hyphae back to their point of origin ; usually they can be traced only a short distance from the sexual bodies. Frequently it is impossible to determine the origin of the sexual organs, particularly when they are produced around a stromatoid body.

The oospores are, as a rule, embedded in the medium, and are often found upon, or in close proximity to, stromatoid bodies. The stromatoid bodies are formed by a process of budding, which, when continued, forms a compact mass with apparently cellular structure, such as is figured on Plate X. These bodies vary in size up to 500 × 350 μ, and when well grown are usually covered by numerous, almost sessile, sexual bodies. The presence of stromatoid bodies is not absolutely constant, nor is the production of oospores dependent on their presence. In some mixed cultures, sexual spores may be found in abundance in parts of the medium in which there are no stromatoid bodies, while in other cultures oospores are not found except in clusters around these bodies. They were found, however, in all oospore-producing cultures on maize-meal agar.

Similar bodies appear to have been found by Dastur (10) in cultures of *P. parasitica*. He states " The oospores in oat-juice agar are embedded in the medium and are as a rule confined to those portions containing matted budding hyphae, which are considered to store reserve material for the fungus. They are invariably empty after the formation of oospores. Very often the oospore is completely entangled in the net work of those hyphae." The stromatoid bodies found in the mixed cultures differ from those described for *P. parasitica*, in that the cells of the former are not empty after the development of the oospores. Moreover, the oospores are produced on the bodies found in the mixed cultures, and not entangled in the net-work as in *P. parasitica*.

Oospores of *P. parasitica* were obtained by Dastur in cultures grown on French-bean-juice agar as well as upon oat-juice agar. It may be inferred from the above-quoted statement that the tangled networks of budded hyphae were not found in the French-bean-juice agar, as only oat-juice agar cultures are mentioned in this connection. It would appear probable, therefore, that the formation of these bodies is to a large extent influenced by the nature of the substratum.

The seven strains under investigation were grown in pairs in mixed culture in tubes on maize-meal agar slants at room temperature. Two cultures were made of each combination of strains ; these differed only as regards the position of the points of inoculation. The strain which was placed near the bottom of the slant in one culture, was placed near the top of the other, and *vice versa*. The room temperature varied from 22° to 29°C during the 5 months these cultures were under observation.

The mixed cultures in which oospores were found are enumerated in Table 6, in which are also shown the range of variation and the mean diameter of the oospores measured.

Table 6.

Measurements of oospores from mixed cultures.

Strains in mixed Cultures	Medium	No. of oospores measured.	Range of variation μ	Mean diameter μ
Cacao and *Odontadenia*	Bean agar	25	19—25	22.12±.210
Cacao and *Odontadenia*	Maize-meal agar	50	21—28	23.78± 148
Cacao and Rubber	do.	35	20—28	23.66±.193
Cacao and *Dendrobium*	do.	25	21—26	23.56±.175
Cacao and Breadfruit	do.	50	22—27	23.96±.122
Papaw fruit and *Odontadenia*	do.	30	17—28	23.43±.278
Papaw fruit and Rubber	do.	1	22	——
Papaw stem and *Odontadenia*	do.	30	19—29	23.07±.229
Papaw stem and Rubber	do.	14	19—25	22,36±.341
Papaw stem and Breadfruit	do.	2	22—23	22.50

The mean measurements of the oospores from the various mixed cultures, grown on maize-meal agar, are fairly constant. The mean

measurement from the mixed culture of the papaw stem and rubber strains is the smallest, but it does not differ significantly from the largest, which was obtained from the mixed culture of the cacao and breadfruit strains. Consequently, the oospores of the various mixed cultures cannot be differentiated by their size. In form also they are alike, and it would appear probable that we are dealing with the same oospore throughout.

The sexual bodies here described agree very closely with the description given by Ashby(3) of the sexual bodies found in mixed cultures of the Phytophthoras from cacao and coconut, grown by him on slants of French-bean agar. He obtained similar oospores when *P. Faberi* was grown in mixed culture with a strain of *Phytophthora* from cotton bolls, or with *P. parasitica*. His observations show that the oospores formed are actually those of *P. Faberi*.

Ashby, however, makes no mention of the presence of stromatoid bodies in his cultures. This, as already indicated, may be due to the fact that the formation of these bodies is influenced by the substratum on which the fungi are grown, and that French-bean agar does not favour their development.

The mean size of the oospores found in Ashby's cultures was 23.3 μ, with a variation from 19-26.5 μ. These measurements agree fairly closely with the measurements given in Table 6. As the latter measurements were made from cultures on maize-meal agar, a further series of cultures was made on French-bean agar, in order to ascertain whether the size of the oospores was constant for both media. The oospores were not produced so freely on French-bean agar as on maize-meal agar; consequently measurements were made of only 25 oospores of the mixed culture of the cacao and *Odontadenia* strains. The mean of these measurements is 22.12 ±.210 μ, which is slightly smaller than that (23.78 ±.148 μ) obtained from cultures grown on maize-meal agar. The number of spores measured is, however, too small to base any definite conclusion on these measurements. From the fact that the measurement from the culture on French-bean agar is very close to that obtained from the mixed culture of the Papaw stem and rubber strains on maize-meal agar, it would appear that the differences observed between the measurements from the different media are probably due to fluctuations in sampling, rather than that the medium has any definite influence on the size of the oospore.

The mean diameter of oogonia from cultures on French-bean agar is, however, definitely smaller than that obtained from cultures on maize-meal agar. On French-bean agar the mean was found to be 25.6 μ, and on maize-meal agar, 30.1 μ. This is due mainly to the much greater thickening of the oogonial wall on the latter medium.

No stromatoid bodies were observed in the French-bean agar cultures, so that it would appear that the formation of these bodies is influenced by the medium. It must, however, be stated that these cultures were not so thoroughly searched as were those on maize-meal agar.

The variability and uncertainty in the production of oospores of certain species of *Phytophthora* are well known ; some portions of a culture medium may contain numerous sexual bodies, while other portions for no apparent reason may contain none. Such variation was found to occur in the mixed cultures.

Mixed cultures of the cacao and *Odontadenia* strains produce oospores freely, and owing to their abundant production there is little difficulty in finding them. They are first produced in the zone at the junction of the two strains, but later they are to be found in the zones occupied by both the cacao and the *Odontadenia* strains. In other mixed cultures, e.g. those of the cacao and *Dendrobium* strains, very few oospores are produced, and these usually occur in clumps at the junction of the two strains. In the mixed cultures of the papaw fruit and rubber strains, and of the papaw stem and breadfruit strains, only one and two oospores respectively were found, although the cultures were very thoroughly searched.

From the variability of the number of oospores found in mixed cultures, it would appear that the potentiality of the various strains for the production of sexual bodies differs. Of the strains which form oospores when grown in mixed culture with the cacao strain, the strain from *Odontadenia* is the most efficient, and that from *Dendrobium* the least. The strain from *Odontadenia* also forms oospores when grown in mixed culture with either of the papaw strains, whereas that from *Dendrobium* does not produce oospores with either.

Table 7.

Oospores in mixed cultures.

		Strain from						
		Cacao	Papaw fruit.	Papaw Stem.	Rubber	*Dendrobium*	*Odontadenia.*	Breadfruit.
Strain from	Cacao	—	0	0	X	X	X	X
	Papaw fruit	0	—	0	X	0	X	0
	Papaw Stem	0	0	—	X	0	X	X
	Rubber ..	X	X	X	—	0	0	0
	Dendrobium	X	0	0	0	—	0	0
	Odontadenia	X	X	X	0	0	—	0
	Breadfruit	X	0	X	0	0	0	—

In Table 7, the mixed cultures in which oospores are developed are represented by X ; the absence of oospores is indicated by O. It will be seen from this table, that oospores are produced only in mixed cultures which contain either the cacao strain or one of the papaw strains. When, however, the cacao strain is grown with one of the papaw strains, and when the two papaw strains are grown together, no oospores are formed. Also when any one of the strains from *Odontadenia*, rubber, *Dendrobium*, or breadfruit is grown in mixed culture with any other, no oospores are formed ; whereas oospores are developed when any one of them is grown in mixed culture with the cacao strain. It is therefore possible to divide the strains into two groups,—the cacao group consisting of the cacao and papaw strains, and the rubber group consisting of the strains from rubber, *Odontadenia*, *Dendrobium*, and breadfruit.

Two strains from one of these groups, when grown in mixed culture, will not form oospores, and it is only by growing a strain from the cacao group with one from the rubber group that oospores are obtained. It should be noticed that the grouping of the strains corresponds with the classification based on the shape of the sporangia and on the size of the chlamydospores.

The above observations would admit of interpretation upon the assumption of heterothallism, though the possibility of hybridism is not precluded. The facts that *P. Faberi* produces oospores when crossed with *P. parasitica*, and that sexual bodies have been obtained by growing *P. infestans* in mixed culture with *P. Phaseoli*, (8), indicate the possibility of hybridism. Owing to the similarity of the strains in pure culture, however, the assumption of heterothallism would appear more probable. Unfortunately, attempts to germinate the oospores have been unsuccessful.

Inoculation Experiments

Inoculation experiments were carried out on fruits of cacao, papaw, *Hevea*, and breadfruit. The fruits were first washed with corrosive sublimate solution and then with sterile water. They were placed in glass dishes, containing a little distilled water in order to provide a damp atmosphere. Only one fruit of the cacao, papaw, or breadfruit was placed in a dish, but as many as four *Hevea* fruits were put together in one dish. In the latter case all the fruits were inoculated with the same strain. All fruits were healthy, well grown though not quite ripe, and were obtained as far as possible from trees not affected by disease. The *Hevea* pods, breadfruit, and papaw fruits were obtained from trees which were

known not to be attacked by *Phytophthora* fruit diseases. Cacao pod rot, however, is so general that cacao pods had to be used from an estate on which the *Phytophthora* was known to be prevalent.

Controls were used in all the experiments. Only one control fruit, and that a cacao pod, gave a positive result. Inoculations were counted as successful only when the disease originated at the point of inoculation. In nature, cacao pods are usually infected at the stalk end or at the tip. Inoculations were therefore made on the sides of cacao pods in order to avoid the possibility of a previous natural infection at the point of inoculation.

The inoculations were made by transferring, from pure cultures, small pieces of mycelium bearing ripe sporangia into water placed on the fruit. Wax rings were placed on the fruits to prevent the water running off. When the inoculation was made through a wound, the wound was made by cross hatching the surface of the fruit with a sharp sterile knife or with a sterile needle.

Cacao fruits. Six inoculations were made with each strain on unwounded cacao fruits. The pods inoculated with the cacao strain showed a discoloration at the points of inoculation after 3 days, and sporangia appeared on the surface in 5 or 6 days. The discoloration rapidly extended over the whole fruit, and was followed by a rich growth of mycelium. Inoculations with other strains on unwounded pods were not successful.

On wounded fruits, all strains gave positive results ; but the discoloration was much later in making its appearance, and the growth of the fungus was not so good, when inoculations were made with other strains, as when they were made with the cacao strain. In some cases no discoloration occurred until the third week from inoculation ; but when established the fungus grew rapidly until, by the end of the fourth week, the pods were entirely discoloured and sporangia and chlamydospores were found in abundance in the aerial mycelium covering the pod. The period elapsing between the times of making the inoculation and the appearance of a discoloration around the point of inoculation, was not constant for any one strain. Of 5 inoculations made on wounded cacao with the strain from papaw stem, two became discoloured in 3 days, and sporangia were present on the 5th day ; two showed no sign of successful inoculation till the 21st day, and one failed entirely. Similar results were obtained with other strains, except the one from cacao which always infected cacao pods readily.

Table 8.

Cross inoculation experiments.

Fruits Inoculated	Inoculations with strain from													
	Cacao		Papaw fruit.		Papaw Stem.		Rubber		*Dendrobium.*		*Odontadenia.*		Breadfruit.	
	I.	S.	I.	S.	I.	S.	I.	S.	I.	S.	I.	S.	I.	S.
Cacao														
Unwounded	6	6	6	0	6	0	6	0	6	0	6	0	6	0
Wounded	5	5	5	2	5	4	5	5	5	4	5	3	5	2
Papaw														
Unwounded	3	1	3	3	3	3	3	2	3	0	3	1	3	0
Wounded	4	4	4	4	4	4	4	3	4	4	4	2	4	4
Hevea														
Unwounded	12	9	12	8	12	8	12	12	12	11	12	9	12	8
Wounded	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Breadfruit														
Unwounded	4	0	4	2	4	2	4	0	4	2	4	3	4	4
Wounded	2	0	—	—	—	—	2	2	—	—	—	—	—	—

I.=inoculations. S.=successes.

Papaw fruits. Three inoculations were made with each strain on unwounded papaw fruits. The inoculations made with the two strains from papaw were the most successful; no inoculation failed. When inoculations were made with these strains, discoloration occurred around the points of inoculation within 4 days and latex oozed from the discoloured area. Hyphae appeared on the surface shortly afterwards, and sporangia and chlamydospores were formed in large numbers. The progress of the disease was rapid, and the whole pod was covered with a dense mycelium in 10 days.

Two inoculations with the rubber strain, and one with the strain from *Odontadenia*, progressed similarly though less rapidly. Not until

the seventh or eighth day did it become evident that the inoculations had taken, but from then onwards the progress of the disease was rapid. No inoculation with the strains from breadfruit and *Dendrobium* was successful.

One inoculation with the cacao strain gave a peculiar result. The cells below the point of inoculation collapsed, resulting in a depression at the surface as though it had been pressed in with the thumb. There was no discoloration and except for the cup-like depression the pod appeared healthy. This area was cut through with a clean knife three weeks after the inoculation had been made. On the following day sporangia were present on the cut surface.

Successful inoculations were obtained with all strains when the papaw fruits were wounded.

Hevea pods. *Hevea* pods were attacked by all the strains, even when the pods were not wounded. The strain from rubber was the most virulent, through the *Dendrobium* strain almost equalled it in virulence. Pods inoculated with these strains were discoloured within 2 or 3 days from inoculation, and sporangia appeared on the surface within 5 days. Hyphae appeared on the surface of pods infected by the strains from cacao, breadfruit and papaw 2 or 3 days later than they appeared on pods inoculated with the strains from *Dendrobium* or rubber. The growths from the papaw strains were the weakest ; in some cases only scattered pustules had formed by the time pods infected with the other strains were entirely covered with mycelium.

Of 12 inoculations with each strain on unwounded pods, 1 with the *Dendrobium*, 3 each with the cacao and *Odontadenia*, and 4 each with the papaw and breadfruit strains were unsuccessful. On wounded pods all inoculations were successful.

Breadfruit. Four inoculations were made with each strain on unwounded bread-fruits. All inoculations with the strain from breadfruit, 3 with the *Odontadenia*, and 2 each with the papaw and *Dendrobium* strains were successful, but no infections were obtained with the strains from cacao or rubber. Two inoculations with the last-named strains were also made on wounded fruits ; both inoculations with the rubber strain took readily, but neither with the cacao strain was effective.

General. Inoculation experiments were not carried out on *Dendrobium* or *Odontadenia* plants. The results of the inoculations on cacao, rubber, breadfruit, and papaw fruits indicate that these fruits are most readily attacked by the strains which were originally isolated from them, and that the majority of the other strains will infect these fruits under suitable conditions. In general, *Hevea* pods are more readily attacked by all strains than are the other fruits used in these experiments Though

the various strains readily attack *Hevea* pods, the *Phytophthora* from *Hevea* does not attack other fruits with equal readiness.

The results are similar to those obtained by Rutgers, who reported "The Phytophthoras from *Hevea*, cacao and nutmeg belong to the same species; only, the line isolated from cacao proved to be more virulent for cacao and *Hevea* and the one isolated from nutmeg more virulent for nutmeg."

Though the *Phytophthora* from cacao will readily infect *Hevea* pods under laboratory conditions, it would appear from general observations that a similar infection does not readily occur in nature. At the Peradeniya Experiment Station, pod rot and canker are prevalent in the cacao trees, but the *Hevea* trees are rarely affected by pod disease, though cases of claret-coloured canker and black stripe disease occur.

The virulence of *Phytophthora* diseases depends to a very large extent upon climatic conditions, and possibly, in some cases, on the stage of development of the fruit at the time of attack. In the low-country of Ceylon, *Hevea* fruits are annually affected by pod rot during the South-west monsoon, though the attack is more severe in some years than in others. At Peradeniya, pod rot and leaf-fall of *Hevea* are rare. The fruits are formed later at Peradeniya than in the low-country, owing to the greater elevation. It was considered that the later ripening of the fruit at Peradeniya was one of the causes of the absence of *Phytophthora* disease, the fruits not having reached a suitable stage of development at the time climatic conditions were most favourable for attack by the fungus. The monsoon rains this year (1923), however, were very prolonged, but still neither pod rot nor leaf-fall became evident; consequently, the late development of the pods cannot be regarded as a sufficient explanation of the non-appearance of the fruit disease.

That the *Phytophthora* from cacao will under suitable conditions readily attack *Hevea* pods in the field is notably demonstrated by Rutger's experiments, already quoted, which had to be stopped after three weeks, as 50 per cent of the fruits in the field had become infected.

The restricted occurrence of other *Phytophthora* diseases is also difficult of explanation. The breadfruit disease has been reported from the Southern Province only, although isolated trees are grown throughout the low-country wet zone and up to 2,000 ft. Though surrounded by *Hevea* attacked by pod rot disease, the breadfruit, in many cases, escapes infection. Similarly, the papaw fruit disease has been reported only from Peradeniya, though papaw trees are grown in both rubber and cacao districts. A *Phytophthora* has only once been found on *Odontadenia*; then it occurred on one of two plants growing near together and surrounded by *Hevea* trees affected by pod rot.

It would appear from the above facts that though a strain from one host plant may attack another host under laboratory conditions, it does not readily do so in nature ; and that the virulence of any strain depends to a large extent on unknown external conditions.

DISCUSSION.

The strains of *Phytophthora* used in these investigations may be divided into two groups by their morphological characters when grown in culture on maize-meal agar. The strains from cacao and from papaw constitute one group, which for convenience has been termed the cacao group ; the strains from *Hevea*, *Dendrobium*, *Odontadenia*, and bread-fruit form the other, termed the rubber group. The cacao group is distinguished from the rubber group by the larger chlamydospores, the smaller length to width ratio of the sporangia, and by the relatively greater production of chlamydospores.

Such grouping divides the strains into two distinct physiological races, (in so far as the formation of oospores is dependent upon physiological characters), as oospores are produced only in those mixed cultures which contain one member from each group. In other words, the members of one group are all of the same sex, but of opposite sex to those of the other group. If the members of the cacao group are regarded as female, then those of the rubber group are male.

The strain from cacao is the type of the species, *P. Faberi*. If all the strains are regarded as belonging to the same species, then the production of oospores in mixed cultures may be explained on the assumption of heterothallism. The two thalli, however, are differentiated, when grown in certain environments, by definite morphological characters. In this respect the heterothallism is different from that observed in such genera as *Mucor* and *Coprinus*, in which the + and — races are usually identical morphologically.

On the other hand, if the members of the two groups, owing to morphological differences, are considered to constitute distinct species, then the oospores must be regarded as hybrid. Whether the production of oospores in mixed culture must be interpreted on the assumption of heterothallism or of hybridism will depend upon whether the members of the two groups are regarded as belonging to one or more species, and, consequently, upon the definition of a species.

To the systematist, a species consists of individuals with similar morphological characters. The characters most useful for taxonomic purposes are those which remain constant under all conditions and are not correlated with certain adaptations to habitat. Plastic characters, which vary with external conditions, are of less value, the value decreasing

as their plasticity increases. Physiological characters, though useful for the separation of distinct strains, cannot yet be regarded as adequate criteria for the differentiation of species. Specific diagnosis must therefore be based on constant structural characters.

The most critical descriptive characters in the systematic treatment of the genus *Phytophthora* are undoubtedly those exhibited by the sexual reproductive organs. Rosenbaum gives the following characters, which may be conveniently used in separating the various species, arranged as nearly as possible in the order of their importance. "(1) The size and morphology of the sexual reproductive bodies, conidia, chlamydospores and other structures; (2) shape of the terminal papillum in the conidium; (3) the ratio of the length to the width in the conidia; (4) variation in the mycelium; and (5) the microscopic growth, time of appearance of spores, and kind of spore forms produced on various media."

The characters by which the strains forming the cacao group are separated from those of the rubber group, viz., the length to width ratios of the sporangia and the size of the chlamydospores, are not constant under all conditions. On some media it is impossible to distinguish the strains by these characters. Owing to the plasticity of these characters, it is doubtful whether they alone are sufficiently marked to delimit the groups specifically.

With regard to the cacao group, if the limits of a species are narrowly set, it would be possible to differentiate the papaw strains from *P. Faberi* morphologically, by their greater development of aerial mycelium and the smaller production of spores, both sporangia and chlamydospores, when grown on certain media. Though such a differentiation may be supported by certain physiological characters, it is doubtful whether the separation of the papaw strains from *P. Faberi*, and the formation of a new species to accommodate them, would serve any useful purpose in systematic mycology. They are best regarded as varieties of *P. Faberi*.

But whether the morphological characters of the strains in the rubber group exhibit sufficiently marked differences to justify their exclusion from *P. Faberi* is a debateable question.

The oospores described in this paper are morphologically identical with those found by Ashby, when he grew *P. Faberi*, from cacao, in mixed culture with a strain of *Phytophthora* isolated from coconut, or from cotton bolls, or with *P. parasitica*. *P. parasitica* forms oospores in pure culture which are substantially smaller than those obtained when this species is grown in mixed culture with *P. Faberi*. The strains from coconut and cotton bolls are morphologically very similar to *P. Faberi* (from cacao), and do not produce oospores in pure culture. The oospores in all these mixed cultures are alike. The fact that the oospores of the

P. Faberi × *P. parasitica* cross are identical with those obtained when *P. Faberi* is grown in mixed culture with either of the strains from coconut or cotton bolls, indicates that their size and characters are determined by *P. Faberi*, and that they may therefore be considered as actually the oospores of *P. Faberi*.

In the present investigation, the occurrence of similar oospores in mixed cultures, in which the strains from papaw have been substituted for *P. Faberi* from cacao, supports the view that the strains from cacao and from papaw must be referred to the same species, notwithstanding that they have different host relationships.

Ashby refers the strain from coconut to the species *P. palmivora*. It would appear from his description, that the cacao fungus (*P. Faberi*) differs from both *P. palmivora* and the strain from cotton bolls in growing less vigorously, and in developing sporangia less luxuriantly but chlamydospores more freely, as well as in not forming the characteristic mycelial aggregates that are usual in cultures of the coconut form. In all other respects, including the conidiophores and shape and size of the sporangia, *P. Faberi* cannot be distinguished in pure culture from *P. palmivora* and the cotton boll fungus, but these last two have not been found capable of infecting cacao pods.

Ashby concludes that the cotton boll *Phytophthora* is apparently identical with *P. palmivora* ; that the absence of oospores, both in pure and mixed cultures of this species, and some growth differences, as well as its inability to infect cacao pods, distinguish it from *P. Faberi*. He consequently regards it as no more justifiable to include it in one species with the latter than to unite it with *P. Meadii*.

In that *P. palmivora* develops sporangia more freely, and chlamydospores less readily, than the cacao *Phytophthora*, it resembles those strains forming the rubber group under investigation. The length to width ratio of the sporangia of *P. palmivora* in cultures on Lima bean agar which have reached their full growth (2-3 weeks) is given (1) as 1.52-1.57, though in young cultures (under a week) the length is relatively greater, the ratio being 1.75-1.77. The smaller ratio agrees closely with those found by me for the cacao group, and the larger approximates those of the rubber group given in Table 4. The change in the length to width ratio of the sporangia with the increase in age of the cultures indicates that the shape of the sporangia is not a sufficiently constant character for the differentiation of species.

P. palmivora differs from *P. Faberi* in minor growth characters, and in attacking coconut tissues readily whereas it will not attack cacao pods. As oospores are formed when it is grown in mixed cultures with the cacao fungus, it would appear to be closely allied with the strains

forming the rubber group. The strains of this group, therefore, were inoculated on wounded, young coconut leaflets and fruits, but without success. Hence *P. palmivora* differs from the strains forming the rubber group as regards host relationship.

On the other hand, one wounded coconut fruit, of three inoculated with the cacao strain, was successfully infected. A dark brown discoloration spread from the point of inoculation until the whole fruit was discoloured. The progress of the discoloration was followed closely by the development of a thick mycelium bearing sporangia on the surface. It would appear, therefore, that *P. palmivora* is closely related to *P. Faberi*, and there seem to be small grounds for the separation of these species morphologically. If, however, the two species are amalgamated, the name *P. palmivora* would take precedence.

In South India and Burma, the species of *Phytophthora* which causes disease of *Hevea* trees has been referred to *P. Meadii*. This species was described by McRae (19) as the cause of wilting of the leaves, fruit rot, leaf fall, bark rot, and partial die-back of the branches of *Hevea* in South India. When first discovered, the fungus was suspected to be *P. Faberi* (18), owing to the similarity of the two species, but a careful study by McRae, of parallel cultures of the South Indian fungus and *P. Faberi* from cacao from Ceylon, showed certain specific differences.

" The sporangium of *P. Faberi* is usually slightly nearer the spherical shape than that of *P. Meadii*. The papilla of *P. Faberi* is, as a rule, more protuberant than that of *P. Meadii*, and the base of the sporangium of the former has a cellulose plug much more frequently than has the latter. .....The main differences, then, between the two fungi are that the oospore of *P. Faberi* almost completely fills the oogonial wall and that no antheridium is present, while in *P. Meadii* the oospore lies loose within the oogonial wall, and a persistent antheridium is invariably present. The differences are so distinct that the two cannot be regarded as the same species "(19). McRae relied on the descriptions of von Faber, Coleman, and Rorer for the description of the oospores of *P. Faberi*, and, as already stated, these probably refer to chlamydospores and not to true oospores. In his own cultures of *P. Faberi*, he found resting conidia only. Consequently, the main difference between *P. Faberi* and *P. Meadii* is that the latter produces sexual spores in pure culture whereas the former does not.

McRae's cross inoculation experiments showed that " under exactly similar conditions *Hevea* fruits were infected readily both by *P. Faberi* and *P. Meadii*, while cacao fruits were infected readily by the former and with difficulty by the latter." These results are similar to those obtained

in infection experiments carried out in Ceylon with the strains from cacao and rubber respectively.

In Burma (11) the *Phytophthora* which causes pod rot, leaf fall and bark rot does not form antheridia, oogonia or oospores, but it does produce chlamydospores in culture and on fruits. In these respects it differs from *P. Meadii* of South India, which produces oospores but not chlamydospores. Otherwise, the two Phytophthoras are similar. It is, however, of interest that " a culture of *P. Meadii* sent to Pusa produced resting conidia there soon after its arrival, and has continued to do so in subsequent sub-cultures. They have appeared in French-bean agar and oat-juice agar, though never so copiously as in cultures of the Burma *Phytophthora* on *Hevea*."(19).

Concerning this, McRae states, " the fact that *P. Meadii* can produce resting conidia rather confirms the identity of the Phytophthoras from Burma and from South India. I have made measurements of the resting conidia from the cultures of the Burma *Phytophthora* and from that of the South Indian *Phytophthora* returned to me by Dastur, and the measurements come very close together. These resting conidia also come fairly close to those of *P. Faberi* in size."

The strain of *Phytophthora* isolated from rubber pods in Ceylon closely resembles the Burma fungus, but differs from the South Indian species in that it does not produce oospores in pure culture, and by forming chlamydospores more readily. The production of chlamydospores would appear to depend to a large extent on climatic conditions, as the South Indian fungus does not produce them at Coimbatore but does when cultures are sent to Pusa.

P. Meadii differs from *P. Faberi* from cacao in forming oospores in pure culture, in certain minor morphological characters, and by not readily infecting cacao pods. If, however, the oospores which occur in mixed cultures containing *P. Faberi* are actually those of *P. Faberi*, as Ashby's observations and the present investigations would indicate, then the morphological difference between *P. Meadii* and *P. Faberi* is considerably reduced, as the oospores of these two species are somewhat similar in size. McRae gives the measurements of the oospores of *P. Meadii* on French-bean agar as 16.4-32.8 × 15.2--32 μ, with an average of 25.5×25 μ; and on *Hevea* fruits as 16-32 × 16-32 μ with an average of 21 × 20.5 μ (cf. Table 6)

Cross inoculations with the strain from rubber in Ceylon give results very similar to those obtained by McRae and Dastur with the Phytophthoras of South India and Burma respectively. The disease in South India, however, would appear to be more serious than it is in Ceylon, as when the trees are attacked, they dry up so that it is hardly

worth while tapping them ; in Ceylon it is usually not so. In 1919, Petch (27) reported *Phytophthora Meadii* from one district in Ceylon. This species was identified by the presence of oogonia on the *Hevea* fruits. Concerning the physiological effect of this species on *Hevea* he states " As far as observations have gone, the difference in the effect of the two species is very marked : during the leaf fall and pod disease caused by *Phytophthora Faberi*. the flow of latex is not notably affected ; but in attacks of *Phytophthora Meadii*, the latex flow diminishes to such an extent that it is scarcely worth while to tap." Although *P. Faberi* and *P. Meadii* are in many respects very similar, their physiological effects on the rubber tree are very different. Both species occur in Ceylon, but *P. Meadii* has rarely been found.

There are. therefore, equally strong arguments against, as in support of, referring the *Phytophthora* isolated from the ordinary form of pod-rot of *Hevea* in Ceylon to the species *P. Meadii*. The strain from Breadfruit is morphologically identical with the Ceylon strain from *Hevea*, but there is little reason for referring this strain to *P. Meadii* in preference to *P. Faberi*.

Though it may be idle to speculate on the origin of *P. Meadii*, it is of interest that McRae. in discussing its possible origin, favours the idea that it " was introduced into South India along with plants and seed (possibly fruits*)that were imported in considerable numbers from Ceylon." The *Phytophthora* from rubber in Ceylon, however, does not produce oospores, except when grown in mixed cultures with *P. Faberi* from cacao. Until these spores have been germinated and the nature of the resulting fungus investigated, the Ceylon *Phytophthora* found on the ordinary form of pod-rot must be regarded as distinct from *P. Meadii*.

Many pathogenic fungi exhibit the phenomenon of specialised parasitism. Forms which differ only slightly or not at all in structure, and which must be included within the limits of a single species as ordinarily understood, may differ markedly in host relationships. The distinct physiological races of many of the rust fungi, e. g. *Puccinia graminis*, are generally recognised. As the present conception of a species is based on morphological characters alone, these forms are regarded as biological varieties. Biological varieties, therefore, differ from species, in that the latter have considerable structural differences by which they can be distinguished whereas the former have not.

For the present, therefore, it would appear preferable to regard the strains from cacao, papaw, rubber, *Dendrobium*, *Odontadenia*, and breadfruit in Ceylon as biological varieties of *P. Faberi*, the strain from *Den-*

* It would appear scarcely possible that *Hevea fruits* would be sent to India from Ceylon—C. H. G.

drobium being probably identical with that from rubber. If this view is accepted, the presence of oospores in mixed cultures may be explained on the assumption of heterothallism, the strains from cacao and papaw being + races and those from rubber, *Odontadenia*, and bread-fruit—races.

SUMMARY.

1. A comparative study has been made of the strains of *Phytophthora* isolated from cacao, papaw, *Hevea*, *Dendrobium*, *Odontadenia*, and breadfruit in Ceylon.
2. Spore dimensions are influenced by environmental conditions. The value of spore measurements as a means of delineating species of *Phytophthora* is considerably diminished, owing to the variable measurements obtained when strains are grown on different substrata, or under different environmental conditions.
3. Oospores were not found in pure cultures, but were present in mixed cultures, in which certain strains were grown in combination.
4. The strains used in these investigations are regarded as biological varieties of *P. Faberi*. The presence of oospores in mixed cultures is explained on the assumption of heterothallism; the strains from cacao and papaw being + races and those from *Hevea*, *Dendrobium*, *Odontadenia*, and breadfruit — races.

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EXPLANATION OF PLATE X.

Fig. 1. Sporangiophore of the strain from *Hevea*, ×130.
2. Sporangiophore of the strain from *Dendrobium*, ×130.
3 & 4. Sporangiophore of the strain from Cacao, ×130.
5. Sporangiophore of the strain from *Hevea*, showing small swellings, ×450.
6. Bladder-like termination of a sporangiophore of the strain from Papaw fruit, ×470.
7. Typical sporangium of the rubber strain, ×500.
8. Typical sporangium of the cacao strain, ×500.
9. Irregular thickening of the inner wall of a chlamydospore, ×470
10. Irregular thickening of a sporangium wall, ×380.
11. A sporangium producing secondary and tertiary sporangia, ×380.
12. A chlamydospore producing a secondary sporangium, ×380
13. A germinating chlamydospore, ×470
14-16. Oospores from mixed cultures, ×700.
17. Part of a stromatoid body with oospores, ×300.
18. Small stromatoid body with oospores, ×300.

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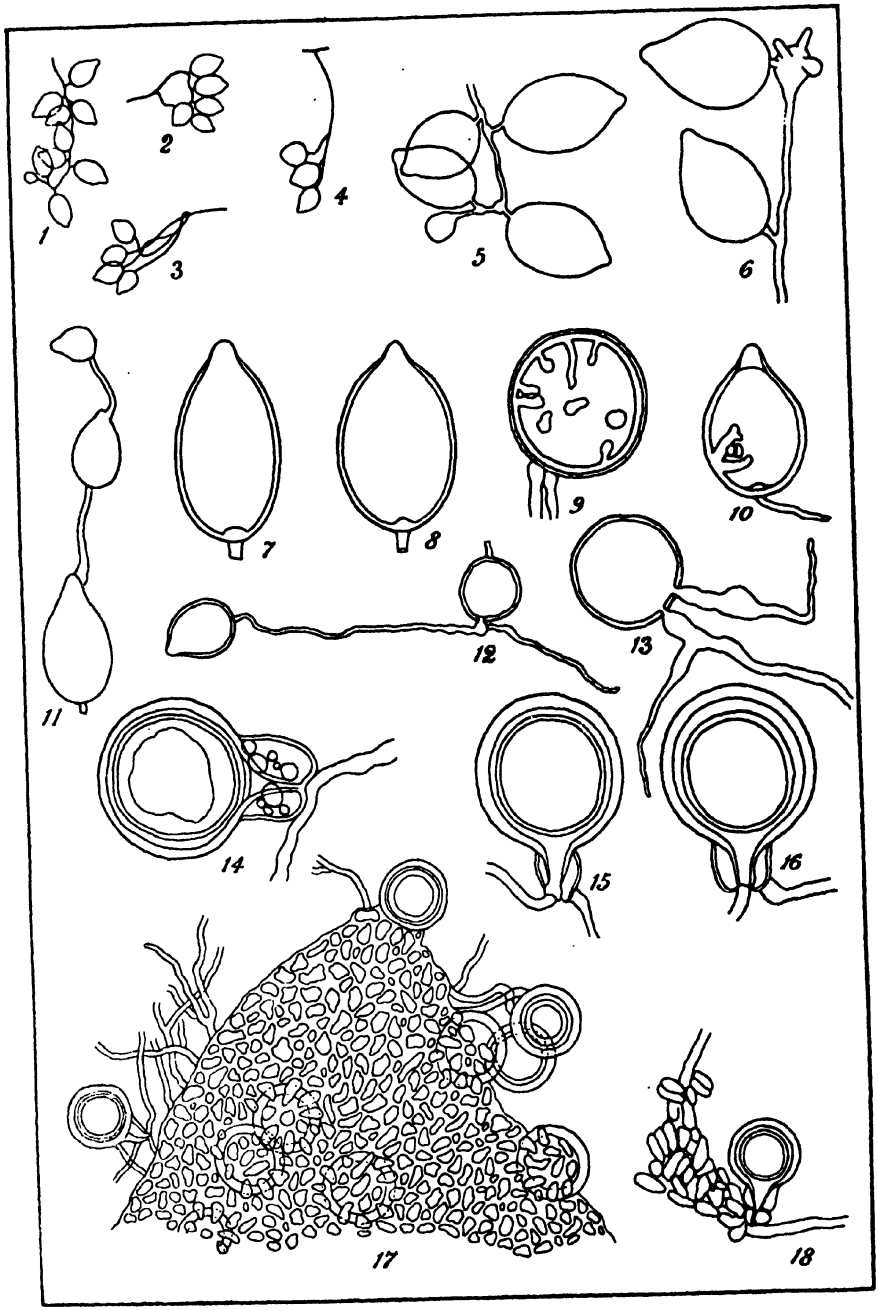
PLATE X.



PHYTOPHTHORA FABERI.

Notes on Some Ceylon Dipterocarpeae.

BY

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WITH ONE PLATE

The following notes consist mainly of descriptions of species, the identity of which had been doubtful up to date owing either to the insufficiency of good specimens or to the absence of flowers or fruit. It also includes the descriptions of flowers of *Dipterocarpus scabridus* Thw. and *Stemonoporus revolutus* Trimen which had not hitherto been published, and of two new combinations *Isoptera lissophylla* and *Vatica Lewisiana*.

Dipterocarpus scabridus Thw., Enum. p. 34 (1858)., C. P. 2692, 2590 (in part) ; Trimen, Fl. Ceyl., 1 (1893), 115.

" A large tree ; young twigs with copious adpressed hairs ; 1.6-9 in., oblong-lanceolate, rounded or acute at base, shortly acuminate, acute, nearly entire, glabrous above, ciliate, veins hairy beneath, lat. veins 12-18, petioles 0.75 in. or more, densely adpressed hairy " (Trimen).

Inflorescence a branched, axillary, lax raceme, shorter than the leaves, bearing several large sessile flowers. Rachis of raceme densely stellate-tomentose. Calyx of 5 united, light green sepals : calyx tube the shape of a 5-sided pyramid, 0.5 in. long, winged, stellate-pubescent : calyx lobes of 2 sizes, two 0. 8-1 in. long, 0.2 in. broad, three 0.25 in. long, 0.3 in. broad, almost triangular in outline ; all lobes densely stellate-pubescent with obtuse, rounded apices and entire sinuate margin. Corolla of five, free, imbricating, lanceolate-oblong petals, 1.5 in. long and 0.5 in. at broadest, tapering for a length of 0.5 in. towards the base : petals leathery, creamy, with a well-marked pink colour half way down the centre of the petals ; both surfaces densely silky tomentose, especially towards the apex ; veins distinct ; apex rounded, reflexed ; margins entire revolute ; bases of petals closely pressed together forming a tube 0.5 in. across, resembling a gamopetalous corolla, the apices of the petals spreading out : the whole deciduous and having the appearance of an apocynaceous corolla. Stamens 30 ; filaments triangular, flat at base

dark brown, closely pressed together, free. Anthers yellow, 0.2 in. long, slightly pubescent, united at their bases, dorsifixed, introrse, dehiscing by longitudinal slits : connective prolonged into a long curved process 0.2 in. long. Ovary silky-tomentose, 5-ridged, 3-celled with 2 ovules in each. Style 0.5 in. long, silky-tomentose. Stigma 2-lobed. " Fruit calyx 4-5 in., tube oblong-ovoid, with 5 strong marked, broad, undulated, vertical wings, generally reaching to the base, slightly stellate-pubescent, lobe wings 3-4 in., somewhat undulated, mottled, smaller obes oblong-rotundate, much undulated and crumpled"(Trimen).

Endemic. Near Ratnapura. Flowers collected in April 1923, in the Botanic Gardens, Peradeniya.

Doona venulosa Thw., Enum. p. 402 (1864), C. P. 3675 ; Trimen Fl. Ceyl., 1 (1893), 123.

Tree large, young parts glabrous and bark of twigs dark; l. 2.5-3.25 in., oval or ovate-oval, rounded at base, suddenly acuminate, lat. veins 6-8, the lower very oblique, ascending, tertiary connecting veinlets very prominent on upper surface.

Flowers 0.75 in. diameter, white, with articulated peduncles in terminal glabrous panicles. Sepals 5 united : 3 outer larger, 0.5 in. long, oblong-obtuse, distinctly veined, apex rounded, of uniform thickness, margins not ciliate ; 2 inner smaller, 0.15 in. long, broadly ovate, less thick towards the fringed margins. Petals 5, free, fleshy, 0.5 in. long, oblong, obtuse, pubescent with adpressed hairs on outer surface, glabrous within. Stamens 15, filaments united at the base into a ring 0.08 in. high, then free for a very short length : anthers introrse, valves 0.08 in. long, equal, oblong, dehiscing laterally ; connective prolonged into a club-shaped process 0.04 in. long. Ovary glabrous, ovate ; style long, sparsely hairy with adpressed hairs ; stigma blunt. Fruit 3-winged, the 2 other fruiting sepals inconspicuous ; wings obscurely veined, closely adpressed to nut at their resinous thickened bases ; cotyledons much plicate and convoluted.

Thwaites named the plant provisionally, neither flowers nor fruit being then available.

Endemic. South of the Island. Flowers obtained, April 1923, R.B.G., Peradeniya.

Hopea cordifolia Trim., Fl. Ceyl., 1 (1893), 126 ; *Vatica* (?) *cordifolia* Thw., Enum. p. 404 (1864) ; C.P. 3726. Mendora, S.

" A very large tree, bark thick, with deep, longitudinal fissures nearly black, young parts softly pubescent ; l. large, 5-7 in., ovate-oblong, strongly cordate at base, subacute, glabrous, shining above, lat. veins 5-7, oblique, conspicuous beneath, with glandular pits in 2 or 3 of their axils ;

petioles 1 in., rugose, stip. very small, subulate, caducous." (Trimen); fl. about 0.2 in. in diameter, on erect axillary panicles of 3 types : (a) the usual form arising in the axil of a leaf with flowers on the primary branches of the inflorescence ; (b) two distinct panicles arising in the axil of the same leaf ; (c) two distinct panicles arising on the opposite side of the stem to the leaf. In the last case the growth of the stem is continued sympodially. Rachis of inflorescence smooth ; pedicel about 0.04 in., dark coloured, rough, thick. Calyx of 5 free imbricating sepals : 3 sepals, which do not enlarge in fruit, broadly oval, with an acute apex, slightly hairy on both surfaces and with margins fringed with hairs (Fig. A 4) ; the other 2 oval-oblong with obtuse apices and margins not fringed with hairs (Fig. A 3) ; all sepals fleshy and thick at base. Corolla of 5 imbricating, falcate petals, slightly connate at the base. Petals 0.4 in. long, 0.12 in. broad, glabrous on inner surface, pubescent on outer ; apex and base obtuse, margins entire, fringed with hairs. Stamens 15 : filaments (Fig. A 2) slender, slightly connate at their flat and broad bases : anthers introrse, oblong, dorsifixed ; connective prolonged into a bristle twice the length of the anthers. Ovary minute, glabrous, 3-locular with 2 ovules in each loculus. Style as long as the ovary. Fruit a winged nut. Two sepals enlarged to about 3.5 in., oval oblong, 9-veined, apex rounded, not tapering towards the base. Nut 0.5 in. beaked.

Endemic. Intermediate region 1500-2000 ft., very rare. Along banks of streams at Tanamilwila and Telula, near the Wellaway River, in Atkalan Korale.

Flowers were first obtained in April 1912 by Mr. F. Lewis on the banks of the Kirinda Ganga at Tanamilwala on the confines of the Uva Province. The following passage from his communication of 6th May 1912 to the late Dr. Lock, then acting Director of Botanic Gardens, throws an interesting light on the history of the discovery and of the identity of this plant. " It may be interesting to note that leaves only of this splendid Dipterocarp were first obtained by Thwaites over 50 years ago. In 1891 my old chief, Broun, (then Conservator of Forests) and I found some decayed fruits of what we believed to be this species and sent them to Trimen. Several years later I secured the fruits and I figured them, and now from the identical spot where, 21 years ago, Broun and I got our fruit material I secured the flowers. Oddly enough these were collected in the same month, April ! You will see by the material sent that the genus *Hopea* is established for this important tree, which before was doubtful."

Isoptera lissophylla (Thw.) Livera, comb. nov.; *Shorea lissophylla* Thw., Enum. p. 402 (1864) ; C.P. 3407 ; Trimen, Fl. Ceyl , 1 (1893) 117.

Yakahalu, S. Arbor ingens, glabra ; ramulae nigrescentes ; folia ovata vel ovato-rotundata vel oblonga, abrupte breviter rostrata, acuta, basibus latis, rotundatis vel subcordatis, 3-5 poll. longa, 0.5-3 poll. lata, venis primariis utrinque circiter 7, his cum costa superne parum depressis, subtus prominentibus, venulis inconspicuis ; petiolus semipollicarus, rugulosus. Paniculae ramis glabris, multiflorae ; pedicellum brevissimum et cum alabastris minute incano-pubescens ; flores 0.5 poll. long., 0.75 poll. lat., incano-pubescentes ; sepali 5, basin liberi, imbricati, ovati ; petali 5, liberi, imbricati, oblongi, marginibus revolutis, externe pubescentes, interne glabri. Stamina 35 : antherae introrsae, non barbatae sed connectivis productis in barbatis spicis. Ovarium oblongum, minute incano-pubescens, 3-loculare, ovulae 6. Stylus brevis. Fig. B.

Thwaites had no fruit when he named this species, and Trimen says, in Fl. Ceylon, I (1893), 118, "fruit not seen." Fruit was first collected by Broun in July, 1893. Roxburgh, in Gaertn. f., Fruct., III., 48, t. 186, describes the genus *Shorea* thus : " Cal. inferus, pentaphyllus imbricatus, foliolis squamiformibus, per maturitate ovario arcte adpressis, basi gibbis, dorso incrassatis, margine scariosis ad ovarii apicem angustatis, et inde in ligulas sensim latiores longas foliaceas lineari-nervosas apice rotundatas productis." This definition is based on the characters of the calyx, which develops into wings in the mature fruit : it is supported by a figure, t. 186.

The earliest mention of fruit of *S. lissophylla* Thw. is in Brandis' Enumeration of the Dipterocarpaceae, Journ. Linn. Soc.,XXXI (1895), 77, where that author says that the other characters of this plant would place it under *Eushorea*. " But A. L. Broun has sent me a sketch of the fruit with short wings, which places it under the section *Brachyptera*. It is, however, an anomalous species of this section." On comparing Broun's fruit with those I have obtained locally, I find that Broun had collected young fruits in which the ripened ovary had not outgrown the calyx in size, and thus this error of determination is easily accounted for. Brandis (*l.c.*), in enumerating the characters of the section *Brachyptera*, says, " segments of fruiting calyx shorter than twice the length of the fruit," and evidently he means that the segments of the fruiting calyx are longer than the fruit. This is not so in *S. lissophylla* Thw. Also the other 6 species of *Shorea* enumerated under this section have 15 stamens each, whereas *S. lissophylla* Thw. has 35.

On the other hand, following Brandis' key (*op. cit.*) pp. 2-3, based on a comparison of all the available species of Dipterocarps, we find that our plant has all the characters enumerated there under *Isoptera*, viz.: " Lobes of fruiting calyx shorter than fruit, round, unequal ; stamens 30-36 ; appendix of connective ciliate ; large stylopodium." Our plant is therefore

an *Isoptera*. This conclusion is confirmed by its possessing characters agreeing with Scheffer's definition of the genus *Isoptera* in Annales Jard. Bot. Buitenzorg, VI (1887), 222, thus : " Calycis floridi tubus brevissimus, toro adnatus ; laciniae ovato-rotundatae, imbricatae ; fructiferi tubus haud auctus, laciniae omnes auctae, horizontaliter patentes, haud aliformes ; 3 latiores rotundatae, 2 angustiores. Stamina 30-36, antheris ovatis, loculis basi divergentis, acutis, valvis aequalibus, connectivo producto setifero. Ovarium 3-loculare loculis 2-ovulatis ; stylus brevis, teres apice 3-angulatus. Fructus coriaceus indehiscens monospermus, calycis laciniis haud inclusus. Semen globosum ; cotyledones crassocarnosae, oleosae, aequales, radiculam superam includentes. Arbores resiniferae. Folia integerrima, parallele penninervia. Paniculae axillares et terminales."

On anatomical grounds this determination is strengthened. Burck, in his " Recapitulation des caractéres anatomiques de la famille et des genres Dipterocarpées," p. 190, Annales Jard. Bot. Buitenzorg, VI (1887), has the following comparison of the internal structure of *Shorea* and *Isoptera*.

	Shorea	*Isoptera.*
Canaux medullaires	Systéme de canaux anastomosés dans la moelle de la tige.	en grand nombre, séparés l'un de l'autre.
Petiole	Anneau externe ouverte vers le côte superieur du limbe.	Anneau externe ferme.

Our species has medullary canals which do not anastomose, and a closed ring of vascular tissue in the petiole.

A large tree with an almost cylindrical stem. Branches glabrous, profuse, black. Bark with deep longitudinal fissures prior to peeling off. Leaves alternate, petiolate ; petiole 0.3-0.75 in., subpeltate, thick, glabrous, rugose ; leaves 3-5 in. long, 2-3 in. wide, broadly oval or oblong, base rounded or subcordate, apex abruptly and shortly acuminate, acute ; margins entire, slightly revolute ; coriaceous, smooth, shining on both surfaces, paler beneath ; midrib and 7 pairs of veins prominent beneath, channelled above. Young shoots softly pubescent. Inflorescence of several drooping flowers in axillary or terminal panicles shorter than the leaves, in the axils of which they arise : rachis of inflorescence sparsely pubescent ; pedicel very short, 0.08 in. Flowers (Fig. B.) yellow, about 0.5 in. long, 0.75 in. across, with a not unpleasant odour. Calyx of 5 free, imbricating, broadly ovate, fleshy sepals with acute apices and entire margins ; outer surface stellate-pubescent, inner glabrous and shining. Corolla of 5 free, yellow, oblong, fleshy, imbricating petals, about 0.5 in.

long, 0.05 in. broad ; at about 0.1 in. from the base the margins revolute for a length of 0.2 in., and then straight again ; apex of petals obtuse, outer surface silky-tomentose, inner glabrous and shining. Stamens 35 (Fig. B. 3.) : lower part of filaments green, fleshy, flat, rectangular, united at their bases ; upper part short, slender ; anthers introrse, of 2 equal valves diverging at the base, attached dorsally to the connective, which is prolonged into a pointed process set with bristles. Ovary oblong, small, silky-pubescent, 3-locular with 2 ovules in each : style very short, terete ; stigma 3-angled. Fruit a nut, not winged, surrounded at base by the slightly enlarged sepals, of which 3 are broader and rounded, and 2 narrower. Nut greyish, silky-pubescent, 0.5-0.75 in. long, 0.25-0.4 in. broad.

Endemic. Moist low-country ; rather rare. " Commonest Dipterocarp on the banks of the Bentota river." Recent specimens from R.B.G., Peradeniya, April 1923.

Balanocarpus zeylanicus Trimen, in Journ. Bot., XXVII (1889), 161 ; Trimen, Fl. Ceylon, 1 (1893), 130 ; *Shorea brevipetiolaris* Thw. mss., in Journ. Bot., XXIII (1885), 205.

Thwaites, in the absence of fruit, doubtfully named this species *Shorea brevipetiolaris*. In 1889, Trimen secured fruit and placed it " with some little doubt in Beddome's genus *Balanocarpus* founded on two species," naming it *B.* (?) *zeylanicus*. In 1895, Brandis (*op. cit.* p. 108) examined 13 other species of *Balanocarpus* and defined the limits of the genus to include the Ceylon species, giving among other characters of the genus, " Stamens 10 or 15."

All these authors state that the Ceylon species has 15 stamens, though there is a sheet, annotated by Trimen, in the Peradeniya Herbarium, of a plant collected in the Botanic Gardens with only 10 stamens. Trimen thought this a different species. On re-examining this specimen I find that some flowers have 15 stamens. This variation in the number of stamens has also occurred in another specimen collected in the Botanic Gardens. These trees were planted out by Thwaites, and Trimen refers to them in Journ. Bot., XXIII (1885), 205. None of the authors mentioned had seen the fully developed flower, and their descriptions were made from young buds only. The description given below is from fully opened flowers.

A small tree with smooth dark bark, young shoots strongly pubescent or glabrous. Leaves 4-5 in., ovate or lanceolate-ovate, glabrous ; lat. veins about 6 pairs, curved, prominent beneath, with occasional glandular pits in their axils ; apex of leaf acuminate, obtuse ; base rounded or subcordate ; margins undulate ; petiole thick, rugose, glabrous or densely

pubescent, 0.25-0.3 in. long. Inflorescence of slender, pubescent, spreading panicles. Flowers shortly pedicellate, secund. Calyx of 5 imbricating sepals, slightly united at the base and of 2 sizes : two outer broadly ovate, almost triangular, 0.04 in. long, 0.04 in. broad, uniformly thick, apex acute ; inner semicircular 0.04 in. long, .06 in. broad, with membranous sinuate margins and obtuse apex; all sepals glabrous. Corolla of 5 free, contorted, fleshy, glabrous, falcate petals, 0.04 in. long, 0.02 in. broad, margin sinuous, base broad, tapering to the rounded apex. Stamens 10-15 : either in 2 rows of 5 each or of 10 outer and 5 inner ; filaments flat at base and united round the ovary, the outer filaments shorter. Anthers introrse, valves equal, connective prolonged to a curved pointed awn equal in length to the anther. Ovary 0.04 in. long, ovoid, no stylopodium, faintly puberulous, narrowed into a tapering style 0.04 in. long. Ovary 1-locular with 4 pear-shaped ovules attached to the axis half way up its length. Fruit ovoid, acute, strongly apiculate ; sepals persistent, enlarged, forming a spreading cup ; pericarp thin, brittle.

Endemic. Very rare ; only known from the summit of Doluwe Kande.

Vatica(Retinodendron) Lewisiana (Trim.) Livera, comb. nov.; *Stemonoporus Lewisianus* Trim. Mss., in Hooker's Trim. Fl. Ceylon, V. (1900), 383.

Arbor ingens, cortex asper. Folia coriacea, elliptica, glabra, superne nitida, pubescens infero, 2.5-3 poll. longa, 1.5 poll. lata, basin rotundata, marginibus revolutis, apex acutus, acuminatus ; petiolus duriusculus, tomentosus, superne canaliculatus. Paniculae axillares : flores pauci, albi, breviter pedunculati. Calyx valvatus, 5-partitus : sepali basin uniti, lanceolati. Petali elliptici, imbricati, saltem externi margines pubescentes. Stam. 15 : antherae introrsae, dehiscentes laterale, externae valvae majores ; connectivi producti. Fructus cum auctis revolutis sepalis.

Petiole 0.5 in., long. Leaves with slightly acuminate apices ; lower surface shortly and closely stellate-tomentose,upper smooth and shining ; secondary veins several, prominent and parallel ; blade 2.5-3 in. long, 1.5 in. broad. Inflorescence, few flowered, axillary panicles of white flowers with prominent yellow anthers. Flowers 0.4 in. across ; stalk 0.2 in. long, angled, densely stellate-pubescent. Calyx 5 valvate sepals united at the base ; sepals lanceolate, margins entire, apex obtuse, densely stellate-pubescent 0.16 in. long, 0.04 in. broad, valvate. Petals 5 elliptical, imbricate, 0.3 in. long, 0.2 in. broad, with prominent midribs ; glabrous on both surfaces except for a breadth of 0.04 in. from the margin on the outer surface where it is pubescent. Stamens 15 in 2 rows, the outer shorter ; anthers introrse, dehiscing laterally ; connective prolonged to an obtuse apiculus : external valves of anther the larger. Filament

slender, about 0.2 in.; anther 0.06 in long ; apiculus 0.04 in. long. Ovary hemispherical, densely tomentose, Style 0.2 in. long, angular, pubescent. Fruit spherical, densely tomentose, with reflexed, enlarged, adnate sepals.

Endemic. Hunuwal Kande near Pelmadulla, F. Lewis.

The following note appears in Trimen, Fl. Ceylon, V (1900), 384, " it is evident that, if this species is to be retained in the genus *Stemonoporus*, the generic character of the latter must be modified to include a plant with a long subulate process terminating the anther."

Thwaites, in Hooker's Kew Journ. Bot., VI (1854), 67, defined the genus *Stemonoporus* thus ;— " Char. gen. Calyx 5-partitus, laciniis aequalibus *fructiferis vix auctis*. Corollae petala 5, aequalia, aestivatione convolutiva, stamina 15, biseriata (5 interna, 10 externa), *monadelpha* ; filamenta in annulum brevem, ovarium cingentem, coalita ; antherae oblongae, introrsae, *singulae poro terminali dehiscentes, connectivo non producto*. Ovarium 3-loculare ; etc."

Our species has (1) a calyx enlarged in the fruit, (2) stamens which are not monadelphous, (3) anthers which dehisce laterally, (4) connective prolonged to an apiculus. Brandis (*op. cit*), in his key, p. 3, based on a comparison of 13 other species of *Stemonoporus* with the several species of *Vatica*, distinguished between the tribes *Vaticeae* and *Vatericae* (to which *Stemonoporus* belongs) in that the former has a valvate calyx, and the latter an imbricate calyx. Our species which has a valvate calyx comes under the former tribe, and agrees with the characters enumerated there under *Vatica*, viz, " Lobes of fruiting calyx equal ; 2 wings in some cases ; anthers short, oval, glabrous ; appendage obtuse." As the lobes of the fruiting calyx are equal, are shorter than the fruit, and are spreading or reflexed in our species, it should be placed under the sub-genus *Retinodendron*.

Stemonoporus revolutus Trimen Mss., Hooker's Trimen Fl. Ceylon, V (1900), 384.

A tree, " branches robust, covered with iron grey bark ; leaves crowded, imbricating towards the end of the branchlets, 0. 5-2 in. long, 1-1.5 in. broad, obovate or obovate-oblong, tip rounded, emarginate or retuse ; base rounded, rigidly coriaceous ; sides revolute when dry, quite entire, smooth above with obscure midrib and veins, beneath pale with a prominent midrib and 7-10 pairs of spreading arched, slender veins venules minutely reticulate ; petiole 0. 3-0.5 in. long, stout. Stipules 0 " (Trimen). Leaves gland-dotted on lower surface. Flowers 0.5 in. across, 1 in. long, 3 or more on long, axillary, slender, rough cymes. Pedicel about 0.25 in. long, rough, green. Sepals 5, reddish-green, oblong-lanceolate, apex acute, margins entire, glabrous on both surfaces,

Petals 5, yellowish-green, imbricating, oval, apex acute, margins entire both surfaces glabrous. Stamens 15, almost sessile, united at their bases into a ring surrounding the ovary; connective not prolonged; anthers opening by a terminal pore. Ovary slightly silky pubescent. Style 0.08 in. long. Fruit brownish, surrounded at base by enlarged sepals; exalbuminous; cotyledons ruminate.

Endemic. Walankande, Panilla.

In Hooker's Trimen's Fl. Ceylon, V (1900), 384, the following note appears under *S. revolutus* Trim. "The specimens having neither flower nor fruit, the genus is doubtful." It is strange that these flowers and fruits which have been in the herbarium since 1893 were overlooked.

In view of the economic possibilities of this order, owing to the valuable timber and resin which some of the species yield, and in view of the confusion which prevails as to the identity of the several species, a number of them being still undetermined, the writer hopes to go into the subject more fully. *Vatica Roxburghiana* Bl., which according to Mendis (2) yields the best kind of wood for underground purposes, *Vateria acuminata* Hayne, "which exudes a clear yellowish resin abundantly, equal to the best Dammar," and the fruit of which is eaten, are examples of the utility of some species. Several species are also suitable as ornamental shade trees. *Vatica obscura* Trimen, a gregarious, dry zone species, with a hard, heavy, brown wood, and pinkish-white, rather pleasant smelling flowers, and affording an odorous sticky gum resin, makes a good shade tree for Colombo or Kandy, as it does not shed all its leaves periodically and as it permits itself to be grown so as to reach any desired height and to give the required amount of shade. This is only one of the many opportunities of combining utility with ornament.

Instances of confusion of species are very common, being largely due to the fact that several members of this order, even though they belong to different genera, have the same Sinhalese name. Mendis (*op. cit.*) p. 11, says of *Doona zeylanica* Thw., "several varieties as regards the colour or value of the timber, such as sapu-doon, etc. are known in Hewahette at least, if they are not the Sinhalese names of some of the following or other species."

In conclusion my most sincere thanks and gratitude are due to Mr. T. Petch, the Government Botanist and Mycologist, for his kindness, advice, and many helpful suggestions during the progress of my work.

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EXPLANATION OF PLATE XI.

A. *Hopea cordifolia* Trimen. 1, Flower. 2, Stamens. 3, Sepal which enlarges to form wings. 4, Sepal which does not enlarge to form wings.

B. *Isoptera lissophylla* (Thw.) Livera. 1, Flower before opening 2, Flower after opening. 3, Stamens. outer and inner view of of anthers showing prolonged bearded connective. 4, Fruit.

C. *Vatica Lewisiana* (Trimen) Livera. 1, Flower. 2, Same with corolla removed. 3, Stamens showing prolonged blunt connective and lateral dehiscence of anthers. 4, Fruit.

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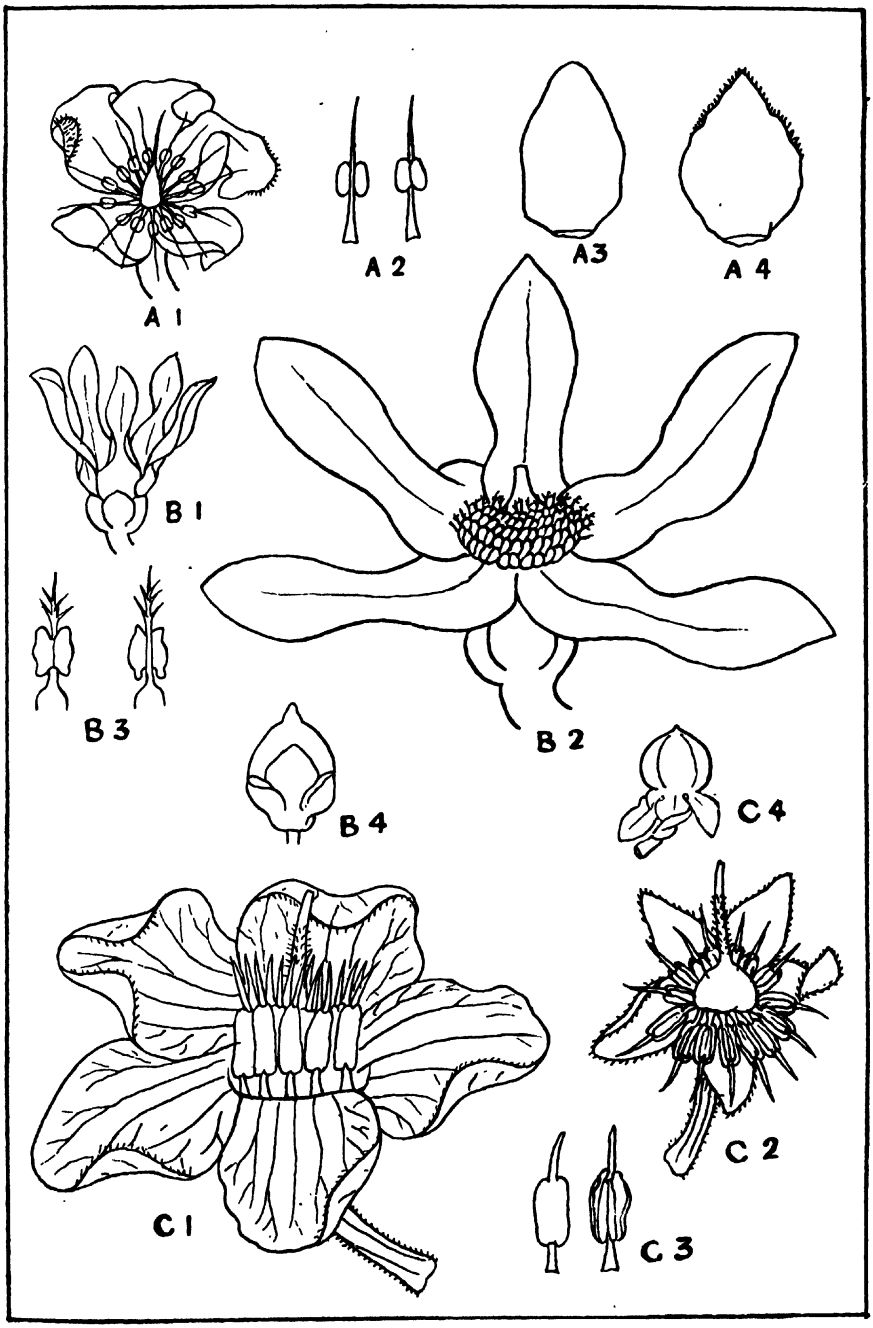
A 1
A 2
A3
A 4
B 1
B 2
B 3
B 4
C 1
C 2
C 3
C 4

Gregarious Flowering.

BY

T. Petch, B.A., B.Sc.

In the "American Journal of Botany" for February, 1923, W. Seifriz has discussed the possible causes of gregarious flowering in plants, among others the bamboos and the Talipot palm.

After noting that Garner and Allard were able, by controlling the time of exposure to light, to cause the field aster, which commonly requires four months to reach sexual maturity, to bear flowers within a month after germination, he points out that the problem of determining the environmental factors which influence the flowering of plants assumes a special interest when considered in reference to those plants which flower only after a period of many years of purely vegetative growth, and becomes particularly interesting when applied to those plants in which all the individuals of a species throughout a given region attain sexual maturity simultaneously.

The theoretical aspects of the problem with regard to biological characters which have hitherto been considered fixed, and the possible effect of environmental factors upon such characters, have been fully discussed by Seifriz. Botanists in the tropics will no doubt agree with his conclusions that at present the theory that gregarious flowering is determined by a germinal factor is without disproof, and that the flowering of bamboos, etc., is not directly induced by preceding or current climatic conditions. But it is only too evident from his paper that the available data are inadequate to afford a foundation for a definite conclusion ; while in some instances they are incorrect.

The acquisition of valid data on this subject is not a light task. The plants in question flower at long intervals, and in some instances no botanist can reasonably expect to observe the full course of two successive generations of the same strain in a life time. Perhaps for that reason no one has thought it worth while to begin accurate observations. Hence, except possibly in the case of some of the Indian bamboos which are under the supervision of a Forest Department, the available data consist largely of general impressions, depending as a rule on memory, or on the inherited recollections of two or three individuals.

It might be expected that, as botanic gardens have been in existence in the tropics for more than a hundred years, they would be able to furnish definite information in respect of many plants. But the realisation of the importance, from a scientific point of view, of keeping accurate records of the operations and events of a botanic garden is of recent date. Half a century ago, the fact that a plant was established in the garden was no doubt considered sufficient. It could scarcely have been foreseen that the date of planting of a particular specimen would be of interest to another generation. Such facts might be remembered by the officer then in charge, but they were not put on record. Consequently, by the time the plant flowered, in the case of monocarpic species with a long life period, all evidence had disappeared owing to the death of the officer under whose direction it was planted.

It is obvious that continuous observations on these species cannot be carried to completion by an individual. The determination of the age at maturity is essentially work for a botanic garden, where it may be continued by a succession of officers in charge. If groups of plants were raised from seed with that definite object, properly labelled, and contemporaneous records filed, it should ultimately be possible to obtain exact information on points regarding which we have at present only recollections and obscured impressions.

Of course, if, as recommended by some, the history of every individual plant in a botanic garden were separately recorded, there would be no occasion for the procedure advocated in the foregoing paragraph. But such a scheme is generally impracticable. The attempt to avoid the Scylla-of no records has, in one instance at least, by the invention of complicated schedules which no staff could possibly attend to, led directly to the Charybdis of again no records.

The present paper merely enumerates the data at present existent in Ceylon regarding the flowering of the Talipot, the Giant Bamboo, etc., with the object of placing on record what few facts are known.

THE TALIPOT PALM.

(*Corypha umbraculifera* L.)

In the case of this species, Seifriz discusses principally the flowering of the palms in the Talipot Avenue in the Peradeniya Gardens in 1918. He states "Ordinarily *Corypha umbraculifera* does not flower gregariously nor at a fixed age, as do certain bamboos. Consequently, when many specimens of the talipot palm do flower simultaneously, one is likely to suspect the presence of some external factor which has aroused the palms to sexual activity."

A botanist, resident in Ceylon, could not unreservedly agree with either of these premises. It is perhaps a matter of definition, but there are well-marked Talipot years, when large numbers flower simultaneously. The railway from Colombo, as it ascends the hills to Kandy, passes through the Talipot zone, and the sight of these magnificent palms, crowned by an inflorescence visible at a distance of several miles, has on various occasions incited a traveller to record the event in the local press. In that way we know that 1894 was a Talipot year, and also 1898. In the latter year, a passenger by train recorded that he counted 21 Talipots in flower between Rambukkana and Kadugannawa, a distance of 12 miles. In November, 1918, the writer, travelling over the same route, counted from the carriage window, 52 Talipots in flower between Alawwa and Peradeniya, a distance of 30 miles which includes the section referred to by the observer of 1898. In considering these numbers it must be borne in mind that the region in question is almost entirely under cultivation, and the Talipot palm is not of sufficient economic importance to make its preservation worth the villager's while.

As regards the Royal Botanic Gardens, Peradeniya, we have dates of flowering of two Talipots simultaneously in 1877, and single examples in 1887, 1890, 1898, 1903 and 1913, in addition to the flowering of the palms in the avenue in 1918. In two of these instances, i.e. 1898 and 1918, flowering in the Botanic Gardens is known to have coincided with a general flowering elsewhere, but for the other five instances we have no similar information. The Gardens were opened in 1822. The list of the trees then growing on the site makes no mention of Talipots, but it is possible that they might not have been considered of sufficient value to record.

Although I have not kept detailed records of the occurrence of Talipots in flower, I would summarise my experience in Ceylon during a period of eighteen years in the statement that there are certain years in which large numbers of Talipots bloom simultaneously, but there are few years (if any) in which a single Talipot cannot be found in flower somewhere in the Talipot zone.

The wel-known Talipot avenue in the Peradeniya Gardens was planted by Trimen. In his diary for 1881 he recorded that 30 young plants (not seed *in situ*) had been planted out in June of that year, but to this entry he afterwards added the note, " nearly all subsequently died." In July, 1882, young palms were again planted, but there is no record of the number supplied or of the number of survivors from the previous year, while the diaries of the following years make no mention of further replacements, though it is clear that such did occur. It is most probable that the plants of 1881 and 1882 were in both cases the progeny of the palms which flowered in 1877.

In 1918, the avenue consisted of 20 palms. Two of these are small and were evidently planted during the present century. Of the remaining eighteen, seven flowered in 1918 and eight in 1922. Three old palms have not yet flowered ; these are smaller than those which have flowered, and were most probably planted to fill up gaps a few years subsequent to 1882.

Seifriz writes " The second objection to be raised against the conclusion that drought caused the flowering of the plants in the Peradeniya Gardens is that nine of the sixteen Talipot palms did *not* flower, and these nine were of the same age and had been growing under the same conditions as the seven which did flower." It will be evident from the foregoing paragraphs that Seifriz was not aware of the actual conditions. It is most probable that all the plants were of the same age from seed, but it is certain they were planted in different years. In that case, if they were of the same age from seed, the plants of 1882 remained in the nursery a year longer than the others, and it is probable that the prolonged stay in the nursery, and the transplanting at a later age, may have had some influence in delaying the age of maturity. Evidence bearing on this point is given below.

The evidence afforded by the flowering of the palms in the Talipot Avenue is insufficient to decide the question whether the offspring of one tree will flower at the same time if grown under the same conditions. It is not certain that the palms were grown from seed from the same tree, though it is very probable that they were grown from seed from trees of the same age (see below) which flowered at the same time; but the young plants were not all grown under the same conditions throughout.

The same uncertainty attends the determination of the age at which the Talipot flowers. If we assume that those planted in 1881 all flowered in 1918, and those planted in 1882 all flowered in 1922, then these palms flowered at 37 and 40 years respectively from planting out. But the age of the young palms when planted out was not recorded. The Talipot grows slowly at first and it may be transplanted from the nursery at a comparatively late age. In the Report of the Royal Botanic Gardens, Peradeniya, for 1907, it is recorded that a row of Talipots had been planted out,—" the progeny of the palm which fruited in 1900," i.e. the one which began to flower in 1898. In the case of the Avenue palms, the probability is that the seeds were derived from the palms which flowered in 1877, and that they were planted in the nursery in 1879. On that supposition, the palms would be 39 and 43 years of age respectively, from seed, when they flowered. But it will be clear that the data lack the accuracy desirable in a scientific determination.

Two Talipot palms flowered simultaneously in the Palm Grove at

the entrance of the Botanic Gardens, Peradeniya, in 1877. Thwaites, in recording the event in his Annual Report for that year, wrote that they had proved glorious ornaments to the Garden for a period of nearly forty years. This palm grove was instituted by Lear in 1839, so that the age of the palms from planting out was at most 38 years, unless Lear planted his palm grove round two existing Talipots. One of these palms was felled, after flowering, in 1880 ; the other was left to decay, and collapsed in October, 1885.

Nothing definite is known about the age of the single trees which have flowered in the Gardens at various times. From their situation, it would appear that many of them were chance seedlings. When the Talipot fruits are ripe, they are carried off by the large fruit-eating bat (*Pteropus Edwardsii*), known in Ceylon as the flying fox, which drops the seed after gnawing off the outer rind. After a Talipot had flowered in 1903, thousands of seedlings sprang up in 1905 under the neighbouring *Ficus Trimeni* and other trees.

Trimen, in recording the flowering of a Talipot in 1887, wrote " The event is of more importance than usual, as, the age of the tree being pretty accurately known, a question often discussed is set at rest. The specimen is remembered well to have been a seedling of two or three years old when Mr. Gardner became Superintendent of the Gardens in 1843 ; it is therefore 46 or 47 years old." The evidence, however, cannot be accepted as reliable. Trimen's diary shows that his statement was based on the recollections of an old retired member of the Sinhalese staff, then about 90 years of age. Memories usually elongate with age, and in the tropics they are notoriously unreliable. It would be easy to confuse the arrival of Gardner in 1844 (not 1843) with that of Thwaites in 1849.

Seifriz remarks that " it would be interesting to know if the flowering of the Buitenzorg Talipot commenced in the same month, June, 1918, as did that of the Ceylon palms. That the palms in Ceylon and at Buitenzorg did flower at very nearly the same time of year is evident from the Peradeniya data and from my observations in Java." The Peradeniya report for 1918 states that the palms " commenced to flower in June, and continued in blossom until the end of the year being at their best in October - November." The record of the Talipot which flowered in 1913 states that it " commenced to flower early in July, 1913, the inflorescence reaching full development by the end of the year." The interpretation of these statements depends on the botanical meaning which is to be attached to the phrase " commenced to flower." Trimen's notes on the specimen which flowered in 1887 are as follows :—" August 4th, the Talipot in the paddock is pushing up its flowering head ; October 15th, the Talipot in paddock now in advanced bud and the inflorescence

feathery; November 25th, Talipot in paddock really in flower." The example of 1890 flowered on November 14th. The Talipot in Ceylon flowers in general from November to January, and the phrase "commenced to flower" no doubt means that the inflorescence began to appear, not that the flowers opened.

It has been customary for the Peradeniya Gardens to distribute seeds of the Talipot to Botanic Gardens in other countries whenever a palm fruited at Peradeniya. Consequently it is possible that the palm which flowered at Buitenzorg in 1918 may have been grown from seed of the palms which flowered at Peradeniya in 1877. Unfortunately we have no record of despatch of Talipot seeds prior to 1883. In that year, seeds were sent to Demarara, Jamaica, Brazil, Hongkong, Madras, Singapore, and Kew. In 1885, seeds were again sent to Demarara. In 1888, seeds were sent to Singapore, and in 1889 to Buitenzorg, Fiji, Florida, Trinidad, and British Guiana. In 1891, seeds were sent to Singapore, Calcutta, Jamaica, and Trinidad.

In 1905, a self-sown seedling sprang up at the base of the palm which flowered in 1903. The latter was the tree, the photograph of which is reproduced by Seifriz on Plate XII, fig. 2. It was in contact with the base of the old stem, and consequently was left unmolested by the weeders and the grass-cutting coolies. It stands practically on the same spot as the parent tree, near the Head Office (the old Museum), and is now a well-grown palm. Thus the age of this tree from seed is definitely known.

The age of the palms planted in a row in the Botanic Gardens in 1907, along the short incline from the Orchid House towards the river, is also definitely known. The seed was obtained in 1900 from the palm which flowered in 1898. But the growth of these is very backward. Three of them, at the foot of the slope, are just (1923) showing a stem, but the others do not yet show any indication of a stem. On the other hand, the self-sown seedling from the palm which flowered in 1903, although it stands on the top of a hill, has a stem ten or twelve feet high. The latter palm is five years younger from seed than those in the row, but in point of development it is at least five years ahead of the best of them.

The foregoing examples support the view that the growth of the Talipot is retarded if the young plants remain for a long time in the nursery. The probable explanation of the fact that seven palms flowered in the Talipot Avenue in 1918, while eight did not flower until 1922, is that the plants were raised from seed which was all sown in the nursery at the same time, but the second group was planted out a year later than the first.

The further development of these trees should prove of great interest. If the Talipot were a strictly gregarious flowerer, all the palms in the row referred to should bloom at the same time, regardless of their size. That scarcely seems probable. I have never seen a dwarf Talipot in flower. Again, if the Talipot flowers at a fixed age, those in the row should flower before the single specimen near the Head Office,—which seems still more improbable.

On the other hand, the palms in the row have been subjected to an unnatural treatment and they are not comparable with palms in a wild state, grown from seed *in situ*. Judging from the size of wild palms at the time of flowering, it is to be expected that the palms in this row will flower at widely different ages. That, of course, remains to be seen, but should it happen, then the Talipot is not strictly a gregarious flowerer.

The fact that large numbers of Talipots of about the same size flower simultaneously indicates that, under favourable or normal conditions, the Talipot blooms at a fixed age. But it would appear probable, from the behaviour of the young palms grown in the Botanic Gardens, that the age at flowering may be greatly increased by unfavourable conditions for growth when the palms are young.

The view that the flowering of the Talipot is induced by a period of drought is not supported by the records of flowering at Peradeniya.

It might perhaps be expected that when the life period of a monocarpic plant is a very long one, this character would, as in the case of morphological characters, be subject to some variation. It is conceivable that, while the majority of the offspring of a plant which flowered and died at the age of forty years might have a life period identical with that of the parent, some might depart from this by a few years on either side of the mean. In that way it might be possible to account for the blossoming of a few plants in the intervening years. It is not, however, evident why there should have been a marked Talipot year in 1898, i.e., at about the middle of the life period of the palms which flowered in 1918. This is paralleled by the behaviour of *Strobilanthes sexennis*. The latter plant flowers and dies at intervals of twelve years. But there are adjacent areas of this plant, the flowering times of which differ by five (or seven) years, i.e., one area flowers and dies about the middle of the vegetative period of the adjacent area.

THE GIANT BAMBOO.

(*Dendrocalamus giganteus* Munro).

The Giant Bamboo was introduced into the Calcutta Botanic Gardens in 1831; and from there a plant was received at Peradeniya in 1856. From the latter, numerous plants were propagated vegetatively, and set out

in the Botanic Gardens, Peradeniya, or distributed to other parts of Ceylon.

Trimen, writing in 1881, stated that no specimen had as yet flowered in Ceylon, but that the plant had flowered at Calcutta in 1861 or 1864 and had survived. In a letter written in 1892, he placed the date of flowering at Calcutta as 1861, and added that the plant, though weakened, did not die.

The earliest indisputable date of the flowering of the Giant Bamboo in Ceylon is 1892 (not 1886), when a plant flowered at Abbotsford, at an elevation of 4460 feet. This plant had been obtained from Peradeniya in 1874, so that the actual plant was eighteen years old at the time of flowering. But it had been propagated vegetatively from the plant introduced into Ceylon in 1856, and the latter had been similarly propagated from the Calcutta plant of 1831. Thus the age of this plant from seed was at least 61 years.

Only a few stems flowered in 1892 at Abbotsford in a clump of about one hundred. Specimens were submitted to Trimen and the identity of the species verified. Macmillan in 1908, recorded, on the authority of the then manager of Abbotsford, that this clump was still alive and " in a condition of mixed flowering."

Trimen, in his letter referring to the above-mentioned occurrence, stated that he had been informed that a clump at Nawalapitiya (1900 feet) had flowered five years previously, but he did not get an opportunity of seeing it. The record is consequently doubtful. In spite of the apparent uniqueness of the Giant Bamboo, it is easy for the non-botanist to mistake other species, e.g., *Gigantochloa aspera*, for it.

The clumps in the Botanic Gardens began to flower in 1903, eleven years after the plant at Abbotsford. One clump bore flowers on sixteen stems out of about four hundred, but none of the other clumps flowered in that year (Annual Report, 1903). Subsequently other clumps flowered profusely, and in 1906-1908, these flowering clumps were conspicuous (and unsightly) objects in the Gardens. The Report for 1907 stated that most of the clumps had been in an irregular condition of flowering for the last three years, while the Report for 1909 stated that only one clump had died out up to that date.

The behaviour of the Giant Bamboo on flowering at Peradeniya may fall into any one of the following categories :—

(1) All, or nearly all, the culms produce flowers and the plant dies.
(2) Nearly all the culms flower, but new vegetative culms spring up at one side of the old clump, and on the death of the flowering part of the latter, the new culms form another compact clump.

(3) The majority of the culms flower and die, but new culms are produced irregularly round the mass of decaying stumps. These new culms may flower or not. In some cases, the non-flowering culms predominate after a few years. Such clumps usually produce, in addition to the normal culms, numerous slender stems, six to twelve feet high, which have the appearance of a different bamboo growing in the old clump. These slender stems may flower or may bear leaves only.

Of the seventeen old clumps in the Botanic Gardens, known to me in 1905, four have flowered and died.

One clump, which stood between the lake and the river, flowered about 1907 and the whole of the old clump ultimately died. But before that happened a few new culms sprang up at one side of it, and these now form a compact clump, without any flowering stems.

Four other clumps have flowered, but have not died, though some of them began to flower before 1910. The old culms which flowered have died, but new culms, some flowering and others vegetative, are still being produced round the decaying mass of roots and stumps. They are not all in the same condition. One consists of a large mound of decaying stumps, with comparatively few new culms of medium size ; it is still producing new culms, but will probably die. The others are not so dilapidated, and the new culms are normal and vigorous. One of these is now in a better condition than it was in 1910, shortly after it began to flower. The new culms tend to be grouped in small clusters, which are probably growing independently. All these are in the condition described as " mixed flowering " in the case of the Abbotsford specimen.

The largest clump in the gardens, standing near the east side of the lake, is just beginning to flower. In 1923, a few culms on one side were in flower, but they were not sufficiently numerous to affect the appearance of the clump.

Seven old clumps have not yet flowered.

The statement in the Annual Report of the Botanic Gardens for 1918, that the flowering of the Giant Bamboo in Ceylon is not now the rare event it used to be, no doubt refers principally to the clumps which have been in a condition of partial flowering for many years, in one case at least fifteen.

It is to be noted that *Fomes lignosus*, one of the common root disease fungi of the tropics, frequently grows on decaying bamboo stumps, and it is probable that in some cases this fungus may cause the death of a clump after flowering.

Clumps may also die before flowering, probably from disease. In

the Annual Report of the Royal Botanic Gardens, Peradeniya, for 1891, Trimen recorded that two or three of the clumps of the Giant Bamboo in the Gardens had died during the year without apparent cause.

As far as Ceylon experience shows, it may be said that (1) The Giant Bamboo does not flower gregariously ; (2) it does not necessarily die after flowering ; (3) clumps may produce both flowering and foliage shoots for a period of at least fifteen years ; (4) a clump which has flowered may subsequently produce only vegetative culms.

BAUHINIA ANGUINA ROXB.

As tending to indicate that the flowering of the Talipots at Peradeniya in 1918 was due to some abnormal climatic conditions, reference has been made to the fact that *Bauhinia anguina*, which had never been known to flower previously in Ceylon, bore fruit in that year. This occurrence requires a more detailed record to prevent erroneous deductions.

A plant which is presumed to be *Bauhinia anguina* has been grown in the Botanic Gardens, Peradeniya, since before 1824. About the year 1860, it covered the pillars of the entrance gate of the Gardens ; and until a few years ago an enormous example arched over the Liane Drive and hung from an adjacent *Ficus elastica*. There is little doubt that the plant is not native to Ceylon. Trimen found it growing at Doluwe-kande apparently wild. But, because of the shape of the stem, it has a reputation as a snake charm and is known as Naga-darana (the track of a snake). Consequently, W. Ferguson suggested that it was probable that the plant had been taken to Doluwe-kande by plumbago miners.

In the Report of the Royal Botanic Gardens for 1918 it is recorded that *Bauhinia anguina* fruited in that year for the first time on record at Peradeniya. This was also the first record of its flowering in Ceylon. But the old plant did not flower. A plant had been propagated vegetatively from the old plant, and established in its proper position in the Arboretum. It was this plant which flowered. Incidentally, it may be noted that the actual flowering was not observed, a single fruit being found on the plant subsequently. Consequently, the identification of this plant remains unconfirmed.

STROBILANTHES.

The best examples of gregarious flowering in Ceylon are afforded by the various species of *Strobilanthes* which cover large tracts in the hill country. These *Strobilanthes* are collectively known as Nilu, Nillu, or Nilloo (Sinhalese Nelu), and their flowering usually attracts attention not only because the sight of a large number of plants massed together in flower at the same time is unusual in Ceylon, but also because when the

Nilu has flowered large numbers of jungle fowl congregate to feed on the seeds and furnish an easy prey for the local sportsmen. Nevertheless, exact data regarding the flowering of the different species have not yet been secured.

Twenty-eight species of *Strobilanthes* have been recorded for Ceylon, and there are probably more. The gregarious up-country species are *S. viscosus* And., *S. Walkeri* Arn., *S. anceps* Nees, *S. asperrimus* Nees, *S. vestitus* Nees, *S. Hookeri* Nees, *S. calycinus* Nees, *S. laxus* And., *S. sexennis* Nees, and *S. pulcherrimus* And. But the name Nilu may be applied to any gregarious Acanthad. H. P. C. Armitage, in the Ceylon Observer of May 3, 1899, described the flowering of the " Nilu " of the Vavuniya district (Dry low-country zone) : the plant was *Stenosiphonium Russellianum* Nees, for which the Sinhalese name is Bu-nelu. The latter plant has the same status in the dry low-country forests, as *Strobilanthes* in the up-country jungles, but, *fide* Armitage, it is biennial.

Trimen (Flora of Ceylon, III, p. 229) referred to these species of *Strobilanthes* as follows,—

" Many of the species which grow in the upper montane zone are remarkable for their gregarious occurrence in vast abundance and over large areas. The principal ones, especially common, and, together or separately, forming unbroken sheets of undergrowth in the forests are *S. viscosus*, *asperrimus*, *calycinus* and *sexennis*, to which may be added less commonly *S. Walkeri*, *anceps*, *Arnottianus*, *vestitus*, *Hookeri*, *laxus*, *pulcherrimus*, and a few others. These live for several years without flowering, growing close together with straight erect stems, which in some reach a height of 8-10 feet, are quite woody, and several inches in diameter. A few flowers may here and there be found every year, but it is not until the plants reach a certain age, apparently usually from 10-13 years, that the whole patch or area bursts into simultaneous blossoming. These patches or districts are often of great extent, and the boundaries between those of different ages are very conspicuous, being as distinct as if artificially sown. After this general and profuse flowering the whole patch begins to wither and ripen the seed—a process which takes several months or even a year (whence ripe seed is rarely found in herbariums), and then dies down. There is probably a patch to be found flowering somewhere in the mountains every year."

As Trimen stated, his information concerning the flowering of the Nillu was derived principally from Mr. T. Farr, who had resided for many years up-country and, as a sportsman and naturalist, had made observations on this subject. It must be borne in mind, however, that these observations are general, and liable to be incorrect as regards species.

Trimen recorded that roots of *Strobilanthes stenodon* Clarke, brought

from Ritigala in 1887 and planted in the Botanic Gardens, Peradeniya, did not flower until 1893 and then died. The period of this species is consequently greater than six years.

Strobilanthes sexennis was so named from an erroneous observation of Walker's, that the plant flowers in its sixth year. Trimen quotes Farr to the effect that great flowering of this as of several other species does not occur sooner than the eleventh or twelfth year. This species is the largest and commonest of the Nillus of the hill forests. It becomes a small tree, up to 12 feet high, with a stem 4-5 inches in diameter.

Of *Strobilanthes pulcherrimus* And., Trimen stated, "This is too striking a plant to be overlooked when in flower, and it is pretty certain that there was no general flowering between the seasons 1881-2 and 1893-4."

Farr, writing in the local press in 1899, stated that he had seen the Nillu flower in different districts many times; in 1870, 1882, and 1894 all in the same Nillu district; in 1875, 1887, and 1889, all in the same Nillu district. He added that there were other flowerings in other districts, and, as far as his experience of 29 years went, the interval between each flowering in each "district" was 12 years.

The term "district," as employed by Farr. means a continuous area covered by *Strobilanthes* which will flower at the same time. His "districts" are not necessarily different geographical districts, such as two different valleys, or even two districts different climatically, but merely two different areas of *Strobilanthes*, whether adjacent or widely separated.

Farr's statements having aroused some criticism, in which the flowering of the Nillu was attributed to climatic conditions, he emphasised and extended them in the following further communication.

"When I wrote to you on the subject of Nillu flowering in Ceylon, I was writing from notes I had made in my "sporting diaries" during the past twenty-nine years.

"Mr. J. Fraser of Abbotsford has ventured to doubt the correctness of my statements and has endeavoured to put me right. He has apparently failed to grasp my application of the term district. I do not refer to a tea or coffee district, but to a Nillu district; and if Mr. Fraser would care to see the boundary of two such districts he can do so the next time he ascends Totapala on his way to fish on the Horton Plains, just above the old ela. The boundary is straight and perfectly distinct. On the Ambawela side, the Nillu, chiefly *Strobilanthes pulcherrimus*, *S. sexennis*, *S. calycinus*, and *S. viscosus*, is now in seed; it flowered (generally) from August to December last year, 1898; it last flowered in 1886. On the Horton Plains side of the boundary I describe, the Nillu

is now from four to seven feet high ; it flowered in 1893 and seeded and died in 1894 ; it will flower again generally in A. D. 1905, Mr. J. Fraser and his dry cycles to the contrary notwithstanding.

" Some of the Nillus, of which there are over thirty different kinds in the island, I believe, are to be found in flower every year, especially *S. viscosus*, but not followed by universal death. Again, during the year preceding the big and universal flowering many plants throw out a spray or two of flower, especially by the sides of roads and notably *S. pulcherrimus* ; but this spasmodic flowering is not followed by death, I think.

" If Mr. Fraser wants to see another Nillu district boundary, let him walk up from Elgin to the Elk Plains *via* the Rajahpatanas, and another between the Horton Plains and North Cove Estate. I know of many more of them.

" I have in my possession notes of the flowerings of Nillu giving dates as follows :—1851, 1857, 1862, 1868, 1873, 1881, 1882, 1886, 1888, 1893, 1894, 1898-, the first five obtained from the late Dr. Trimen when in correspondence with him upon this subject in 1893. These dates were taken from dried specimens in his possession. By the dates I can trace back a good many of the Nillu districts I know, " duodecennially," if that is the correct term.

" Some of these specimens may possibly have been collected in the year preceding the universal flowering. An unusually dry season would probably induce more blossom among the Nillus than a wet one, in the the year preceding its general flowering."

The largest Ceylon *Strobilanthes*, and the one which, in general, forms the predominant part of the undergrowth in the *Strobilanthes* areas of up-country jungles, is *Strobilanthes sexennis*. It is when this species flowers, that the general Nillu flowering is noticeable ; and when it dies in consequence of flowering, the dead stems, covering areas extending for miles, are an equally conspicuous feature of the landscape. The smaller species, *S. pulcherrimus*, *S. calycinus*, *S. anceps*, and others, flower and die at the same time on the same areas, but there would appear to be just a possibility that these species may die at other times, and that their death may pass unnoticed as they are more or less hidden from view by the dominant *S. sexennis*. That, however, is merely a suggestion for future observers.

In giving dates for the flowering of *Strobilanthes*, it is necessary to cite two successive years for each flowering. In these cases of gregarious flowering, the plants, in general, flower during the North East Monsoon in up-country districts ; and the flowering period, beginning in August-October, may extend into the following year, the plants being dead before the next September.

Confining attention to *Strobilanthes sexennis*, we have the following data. In 1922-23, this species flowered and died on the Horton Plains, on one area at Hakgala, on the Elephant Plains, in the jungle from Nanuoya to Single Tree Hill, and on Pedrotalagalla on the area traversed by the path to the peak. These areas extend over a distance of eighteen miles. In 1910-11, the same area of *Strobilanthes sexennis* flowered and died at Hakgala, but no records are available for the other localities. Farr recorded the flowering and death of this species on one area in the Horton Plains district in 1898-99, and in 1886-87.

Another area of *Strobilanthes sexennis*, near the summit of the Hakgala Peak, flowered in 1917-18. *S. sexennis* flowered at Nuwara Eliya in the same year. The Hakgala area flowered previously in 1905-06, and at the same time there was a general flowering on the Horton Plains probably in the second of Farr's districts, as predicted by him six years before. The previous date given by Farr for this area is 1893-4. Nock also noted *S. sexennis* in flower both on the Horton Plains and at Nuwara Eliya in 1893.

We can probably trace the flowering of this second area at Hakgala further back by the fact that *Campbellia aurantiaca*, a root parasite of *Strobilanthes sexennis* in Ceylon, which has only been collected recently when the *Strobilanthes* flowered, was collected at Hakgala in 1881 and in 1869.

The dates show that there is an area of *Strobilanthes sexennis* at Nuwara Eliya which flowers and dies at the same time as areas of the same species at Hakgala and on the Horton Plains, the interval between successive flowerings being twelve years. There are also other areas of the same species at Nuwara Eliya, Hakgala, and on the Horton Plains, which flower and die simultaneously, the interval between successive flowerings being again twelve years. But there is an interval of five (or seven) years between the times of general flowering and death of the two series.

The one series runs 1917-18, 1905-06, 1893-94, 1881-82, 1869-70, 1857-58; the other, 1922-23, 1910-11, 1898-99, 1886-87, 1874-75, (1862-63), 1850-51.

The localities and dates on the Peradeniya herbarium specimens of *Strobilanthes sexennis* are Adam's Peak and Ramboda, 1851; Dimbula, April, 1852; Nuwara Eliya, 1853; locality indecipherable, 1857; between Ramboda and Maturatta, January 1859; between the Elk Plains and the Horton Plains, February, 1882; Abbotsford Dimbula, August 1885; Horton Plains, November, 1893; Horton Plains (Maha Ellia road), January, 1906; Horton Plains, jungle path, January, 1906; jungle above Hakgala, April, 1906, November, 1906.

The specimens, Hakgala and the Hortons, 1906, 1893, and 1882, fit in the first series. The specimen from an indecipherable locality falls in the same series. Nuwara Eliya, 1853, does not fit in with either of the known Nuwara Eliya series. Adam's Peak and Ramboda, 1851, fits in the second series. The Dimbula specimens, and those from between Ramboda and Maturatta, are from other districts than those covered by the two series which have been determined. The two Dimbula specimens are not concordant with one another. The flowering date, August, 1885, if it refers to a general flowering, should be 1885-86, while April, 1852, should refer to a general flowering 1851-52.

Of the dates given by Farr, omitting those from herbarium specimens, 1869-70, 1881-82, 1893-94, fall in with the series 1905-06, and 1917-18. 1874-75, 1886-87 and 1898-99 similarly fit in with the recorded dates 1910-11, and 1922-23. The only discordant date is 1888, and it is possible that this may refer to another series in a different district ; it fits in with the Dimbula date 1851-52.

The area of *Strobilanthes* at Nuwara Eliya which flowered in 1922-23 was not examined until September of the latter year, and it was then possible to identify only *S. sexennis*. In the area which flowered at Hakgala during that period, *S. pulcherrimus* grew together with *S. sexennis* and flowered and died at the same time. On the Horton Plains in November, 1893, *S. sexennis*, *S. pulcherrimus*, *S. viscosus*, *S. calycinus*, *S. anceps*, and *S. vestitus* were in flower at the same time ; and at Nuwara Eliya in August of the same year, *S. sexennis*, *S. anceps*, and *S. asperrimus*. In 1917-18, *S. sexennis*, *S. calycinus*, *S. anceps*, *S. Hookeri*, *S. vestitus*, and *S. viscosus* were in flower at Nuwara Eliya.

In December 1913, a few stunted plants of a *Strobilanthes*, about two feet in height, were found in flower on the hill side (Hantane) above Peradeniya. They were growing on a piece of waste ground by the side of a road and had evidently been cut down on one or more occasions. It is probable that they had originated from seed washed down by an adjacent stream from the jungle on the top of Hantane. These plants were thought to be one of the rarer Ceylon species, and consequently seed was gathered in March, 1914, and sown in pots, and the seedlings planted out in the Botanic Gardens, Peradeniya, towards the end of the year. They did not flower until October 1921, by which time they had formed a tangled clump, about 10 yards long and 5 yards wide, rising to a height of 10 feet. There was no sporadic flowering previous to the general flowering of the whole mass, and all the plants died after ripening seed. Unfortunately the species proved to be merely *Strobilanthes viscosus*.

Thus, at Peradeniya, *Strobilanthes viscosus* in this instance flowered at the age of seven and a half years from seed, i.e., the interval between successive flowerings was eight years. There was no annual flowering, and no flowering in the year previous to the general flowering, as claimed by Farr for this species.

At the end of 1921 and the beginning of 1922, *Strobilanthes Walkeri* was in flower by the stepping stones in the southern boundary ravine on the Hakgala reserve. From the jungle on the Hakgala hill, several ravines run down across the patana (grass land), each serving as a channel for a small stream which drains the forest above. These ravines are densely crowded with trees and shrubs, and form so many belts of jungle running straight down the hill side. In February, 1922, when collecting in the southern ravine, where the shade is so dense that the ground flora is almost limited to ferns, I gathered a specimen of a *Strobilanthes*, only about 7 inches high, but in flower. This proved on examination to be *S. Walkeri*. The stunted plant under dense shade had flowered at the same time as its normal relatives, about 6 feet high, in the open space by the side of the stream, being, in all probability, of the same age as the latter. This incident goes to prove that *S. Walkeri* is strictly a gregarious flowerer, all plants of a given patch flowering at the same time, whatever their size.

Some of the difficulties attendant upon the determination of the age of a particular species of *Strobilanthes* at flowering will be evident from the foregoing records. It is not sufficient to know that the species flowered in a certain year in a given district, e.g., the Nuwara Eliya jungles, as there may be more than one patch of that species in that geographical district. It is necessary to observe the flowering of one particular patch, definitely marked down without a possibility of error.

Again, several species of *Strobilanthes* may grow together, and it is possible that these may flower at different ages. Consequently, an exact determination of each species in flower is essential, not a general impression of the whole mass. Farr cited *S. sexennis*, *S. pulcherrimus*, *S. calycinus*, and *S. viscosus* as flowering simultaneously at intervals of twelve years. But at Peradeniya (1600 feet), *S. viscosus* flowered at an interval of eight years, while at Hakgala (6000 feet), *S. sexennis* flowered at an interval of twelve years. It is possible that the age at flowering may be modified by the elevation, but on the data available the period of *S. viscosus* is shorter than that of *S. sexennis*.

Observations are also required to check the statement that a few flowers are produced in years prior to the general flowering. This is at variance with the observations made on *S. viscosus* at Peradeniya, but the latter plants were only few in number. They were, however

allowed to run wild, that is, they did not receive any cultivation, pruning, or weeding after being planted out. It would seem possible that the statement in question may have been based on the flowering of different species in different years, the rarer species earlier than the rest.

To the foregoing difficulties must be added that few people now remain long enough in one locality in Ceylon to carry on continuous observations which may have to be extended over a period of twelve years before the first step is reached, even if one is able to start from the observed death of a *Strobilanthes* patch. The necessary observations can, however, be easily carried out in connection with a Botanic Garden in a hill station, and it is hoped that this will be undertaken at Hakgala.

As *Strobilanthes* tracts, composed of the same species but flowering at different times, may exist side by side, it would appear that the flowering of these *Strobilanthes* is not dependent upon climatic conditions.

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Revisions of Ceylon Fungi

PART VII

BY

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273.—Lepiota carpophylla B. & Br.

This was described by Berkeley and Broome as "Pileo convexo obtuso subcarnoso subfulvo, centro pulverulaceo, margine fibrilloso; stipite recto concolori e farcto cavo; annulo descendente mobili candido; lamellis stramineis ventricosis postice attenuatis approximatis. Pileus 2 inches across, dull tawny, convex, pulverulent in the centre, fibrillose towards the margin; stem $1\frac{3}{4}$ inch high, $\frac{1}{4}$ thick, of the same colour, even; ring descending, moveable; gills $1\frac{1}{2}$-2 lines wide, ventricose, straw-coloured, attenuated behind, approximate; spores broadly ovate, .00025 inches long."

This grows at Peradeniya among grass, usually solitary. The pileus is 4.5-7.5 cm. diameter, broadly convex or almost plane, feebly umbonate, red-brown in the centre becoming paler outwards, or streaked radially with red brown, on a pale brownish white or pale coffee-coloured ground, the surface splitting into minute, adpressed, fibrillose scales. The stalk is 4-5 cm. high, about 1 cm. diameter, almost equal, stout, pale brown, covered with very minute brown points, stuffed then hollow. The ring is ascending, moveable, stout, white internally, brownish externally, with red-brown warts on the upper edge. The gills are white, then cream or with a brownish tinge, free, crowded, 5 mm. broad, equal, rounded exteriorly, rounded or attenuated behind. The spores are white, oval, 5-6 $\times 3\,\mu$.

Berkeley and Broome's description of the pileus and stalk would appear to be a misinterpretation of the painting sent by Thwaites. The species differs from *Lepiota erythrogramma* in the darker colour of the pileus, and in its stout coloured stalk.

274.—Lepiota leontoderes B. & Br.

In Ann. Perad., IV, p. 383, this species was considered identical with *Lepiota phlyctanodes* B. & Br. Specimens recently collected at Peradeniya have shown that it is distinct.

The pileus is broadly conical, umbonate, becoming repand, up to 8 cm. diameter, dull tawny brown, darker fuscous in the centre, minutely adpressed silky, the surface broken concentrically, covered with scattered, irregular or subconical, corky warts. The flesh is white and compact. The gills are white or cream-coloured, moderately crowded, widely free, not rounded behind, narrow, somewhat dry. The stalk is up to 8 cm. high, 9 mm. diameter below, slightly attenuated upwards, truncate at the base, tawny brown and innately squamulose or striate with brown lines at the base, becoming paler upwards, almost solid, with a narrow central cavity. The veil is dependent, almost arachnoid towards the margin. The spores are white, narrow-oval, 4-6 × 2·5-3μ.

275.—Lepiota ceramogenes B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon No. 50, from Thwaites 1191 cum icone, as "Pusillus, stramineus ; pileo e campanulato convexo umbonato glabro vel parce granuloso margine appendiculato ; stipite brevi, annulo fugaci ; lamellis ventricosis candidis approximatis. On the soil of flower pots, June 1869. Pileus 2-3 lines across, campanulate, then plane and umbonate, straw-coloured, smooth or slightly granulated, margin appendiculate, even ; stem $\frac{1}{3}$ inch high, $\frac{1}{3}$ line thick, having a few fragments of the ring above ; gills white, ventricose, $\frac{1}{2}$ line wide : spores oblong, ·00025 long. The gills turn red in drying."

This was re-discovered at Peradeniya in June 1919, growing in flower pots. The pileus is at first hemispherical, or conico-campanulate, becoming broadly convex, or plane, even or obtusely umbonate, up to 8 mm. diameter, lemon yellow at first, becoming pale yellowish white, and almost white when old ; it is densely pruinose with minute warts which are composed of spherical thin-walled cells up to 40μ diameter. The margin is appendiculate. The gills are white, broadly ventricose, rather distant, free but close to the stem. The edge of the gill bears a few cystidia, either broadly clavate with a rounded apex, or cylindric, narrowed above, with a truncate apex, 24 × 10μ. The stalk is up to 1 cm. high, 1 mm. diameter, equal, or slightly inflated below, pinkish white, fuscous towards the base, pruinose. In my specimens, the whole of the veil is attached to the margin of the pileus. The spores are white, oblong oval, 4-5 × 2·5-3μ. The gills turn dark in drying. It grows in groups of about half a dozen.

In Fungi of Ceylon, No. 71, Berkeley and Broome described *Lepiota melichroa*, from Thwaites 743 cum icone. The description is "Pileo hemisphaerico umbonato pulverulento estriato ; stipite gracile flexuoso pulverulento, annulo obsoleto ; lamellis candidis. On the ground,

Peradeniya, Sept, 1868. Gregarious; pileus not half an inch across, honey-coloured, pulverulent, as is the flexuous stem, half an inch high, $\frac{1}{3}$ line thick; gills white, dark when dry; spores oblong ·0002 long."

From the figure and the herbarium specimens, *Lepiota melichroa* is identical with *Lepiota ceramogenes.*

276.—Collybia endochorda B. & Br.

In Ann. Perad., IV, p. 374, the writer combined this species with that which Berkeley and Broome referred to *Amanita vaginata* Bull. A specimen recently collected, however, (June 1923) shows that this allocation was incorrect; *Collybia endochorda*, though it has a stalk which closely resembles that of some forms of the *Amanita*, has a different pileus, as shown in the original painting.

The pileus is about 7 cm. diameter, broadly convex, then irregularly repand, depressed in the centre, dark blackish brown, becoming paler when dry, glabrous, with a cartilaginous cuticle, which is radially ridged and puckered. The flesh is white. The gills are white, rather distant, adnate, with a decurrent tooth, slightly ventricose behind, arcuate towards the outer end. The stalk is about 7 cm. high, 7 mm. diameter, expanded at the base, slightly attenuated upwards, white and longitudinally striate above, clothed below with clusters of minute grey-brown or blackish points often arranged in transverse bands, stuffed; it has a conical root attenuated below into a narrow cord. The spores are white, globose, 12-14μ, or broadly elliptic, 13-15 × 12μ, with a large conical apiculus.

The original painting shows a longer stalk, more attenuated upwards, and a pileus rather bright brown in the centre, with a well-defined, dark brown, outer ring.

The species referred by Berkeley and Broome to *Amanita vaginata* differs slightly from the British form, but it appears to be too close to be separated from it. The pileus is up to 10 cm. diameter, at first broadly conico-convex, then almost plane, obtusely umbonate and depressed round the umbo, at first blackish, then lilac grey or brownish grey, slightly viscid at first, tuberculato-sulcate in a broad zone at the margin, frequently splitting, rarely bearing fragments of the volva. The stalk is up to 21 cm. high, 2 cm. diameter at the base, attenuated upwards, purple grey or lilac grey, densely silky fibrillose, the outer layer usually cracking transversely so that the stalk shows white and grey irregular transverse bands, stuffed then hollow. The gills are free, narrow, almost equal, attenuated outwards, rather crowded, with a crenate edge, white, sometimes becoming pale grey, and usually acquiring a brown edge. The spores are globose, 8-12μ diameter, with a large apiculus.

The volva is white, spongy, pointed below, up to 6 cm. high and 5 cm. diameter.

Volvaria geaster B. & Br. is a specimen of *Amanitopsis vaginata* emerging from the volva, the sulcate margin of the pileus being just evident.

277.—Hygrophorus tricolor B. & Br.

Hygrophorus tricolor was described by Berkeley and Broome (Fungi of Ceylon, No. 366) as " Pileo primum digitaliformi demum expanso umbonato glabro ; stipite candido subcavo glabro ; lamellis versicoloribus truncato-adnexis (No. 794, cum icone). Pileus 1·5-1·75 inches across, at first obtusely conical, yellow in the centre, scarlet towards the lobed margin, then expanded, umbonate, slightly striate, smooth: flesh reddish beneath the cuticle ; stem 2 inches high, 0·25-0·3 inches thick, nearly equal, white, smooth, stuffed ; gills ventricose, truncate behind, adnexed, variously shaded with yellow and red. Spores 8.75-10μ long, broadly elliptic."

I have not met with any *Hygrophorus* which answers exactly to Berkeley and Broome's description. It is possible, however, that a species which has been collected at Henaratgoda may be *Hygrophorus tricolor*, though it differs in several respects from the description and figure. It is described here provisionally under Berkeley and Broome's name, as it is worthy of record on account of its peculiar coloration.

In some specimens the pileus is uniformly red or yellowish red. In others, there is a central circular yellow area, occupying about half the surface of the pileus, with a red outer zone, the two colours being separated by a distinct, deep red line. Other specimens have half the pileus red and the other half yellow, while others have a red pileus with one or more well-defined yellow sectors extending from the centre to the circumference. The colour of the gills corresponds with that of the pileus ; beneath the red areas the gills are red, while beneath the yellow areas they are yellow, the two colours being sharply defined. If the pileus is red, the stalk is red, or red with yellow transverse patches, but if the centre of the pileus is yellow, the stalk is yellow. The fungus grows in troops, and all the variations described occur together.

The pileus is up to 1·75 cm. diameter, convex, then almost plane, feebly umbilicate in the centre, becoming hoary when drying; when quite dry it turns white. The stalk is up to 2·75 cm. high, 3 mm. diameter, equal and terete, or flattened and lacunose, expanding upwards, glabrous, stuffed. The gills are moderately distant, thick, ventricose, with an irregular edge, sinuato-decurrent.

Berkeley and Broome describe the gills as truncate behind and adnexed. In the figure they appear to be free. In view of the diffi-

culty of ascertaining the nature of the attachment of the gills from dried specimens, and the probable error of a draughtsman unacquainted with mycology, these differences might be regarded as unimportant. But the figure shows a white stalk, and if that is correct it is probable that the species here described is not *Hygrophorus tricolor*. On the other hand, it would appear improbable that two species should have the same peculiar coloration of the pileus.

278.—Pluteus phlebophorus Ditm.

This species was recorded for Ceylon by Berkeley in Decades of Fungi, No. 149 (Hooker's London Jour. Bot., VI, p. 479) from specimens sent by Gardner, the collection number being Gardner 46. The record was repeated in the Fungi of Ceylon, No. 178, but no specimens of this species were sent by Thwaites. On reference to Gardner's painting, No. 46, it is seen to be a fairly good representation of *Oudemansiella apalosarca*, and an examination of the specimens confirms this. The specimens, three in number, are small, not exceeding 2.5 cm. in diameter, but they show the characteristic spherical spores, 16μ diameter.

In Fragmente zur Mykologie, Mitt. VI. p. 1, von Höhnel referred *Oudemansiella apalosarca* (=*Collybia apalosarca* B. & Br.) to *Oudemansiella Canarii* (Jungh.) v. H. (=*Agaricus Canarii* Jungh.). Junghuhn described his species as having free, narrow gills and a volva, and stated that it grew on living branches of *Canarium commune*. *Collybia apalosarca* has broad gills, adnate or adnato-decurrent, and though it has a thin universal veil, it does not show any volva when expanded. Further, it always grows on dead wood. Practically the only resemblances between *Collybia apalosarca* and the description of *Agaricus Canarii* are that the stalks are solid, the spores abundant, and the pileus (more or less) white. If there is no type specimen of Junghuhn's species in existence, it scarcely seems possible to correlate it with *Collybia apalosarca*, in view of the discrepancies between the two descriptions. Under such circumstances, identification is merely guess-work, and it would seem preferable, if any stability of nomenclature is to be attained, that such indecipherable descriptions should be discarded.

279.—Hypholoma fasciculare (Huds.) Fr.

Hypholoma fasciculare was recorded for Ceylon by Berkeley from specimens collected and figured by Gardner (Gardner No. 45, *cum icone*). It was also recognised by Berkeley and Broome among the fungi sent by Thwaites, and was recorded in the Fungi of Ceylon, No. 274, from Thwaites Nos. 746, 759, *cum iconibus*.

There are four drawings of these numbers in Herb. Peradeniya, one of No. 746 and three of No. 759. No. 746 shows hemispherical pilei and is marked " young state " by Thwaites : it was labelled *A.* (*Hypholoma*) *fasciculari*s by Berkeley. The figure of the mature examples of No. 759 was labelled with the same name, but a second figure 759, which shows broadly convex pilei and is indistinguishable from the figure of 746, was labelled *A.* (*Flammula*) *Janus* B. & Br., while a third figure of 759, in which the pileus is shown somewhat acutely umbonate, was also labelled with the latter name.

Flammula Janus was separated by Berkeley and Broome from Thwaites 759, and was described in Fungi of Ceylon, No. 207.

There is no difficulty in determining which Ceylon species was assigned to *Hypholoma fasciculare* by Berkeley and Broome, but one has considerable doubt in accepting their identification, and after considering the matter on several occasions it appears to me that it is preferable to regard the Ceylon fungus as a different species.

This species grows gregariously on dead stumps, either solitary, or in groups of three or four arising from the same point, but in the latter case the stalks separate widely from the base, and are not fasciculate. It usually grows laterally on the stump, not at ground level. Its mycelium runs through the soil, and appears at the surface in minute chalky-looking patches, from which tufts of sporophores are produced.

The pileus is at first hemispherical, then broadly convex, sometimes repand, even, or minutely umbonate with a rounded or acute umbo, yellow brown to reddish brown in the centre, pale yellow to greenish yellow outwards, smooth, up to 2·5 cm. diameter. The flesh is yellow, almost absent except over the stalk. The stalk is up to 4 cm. high, 2·5 mm. diameter, equal, greenish yellow, turning brown when handled, glabrous, shining, here and there lacunose, stuffed, then with a narrow central cavity ; there is no trace of a ring. The gills are narrow (2 mm.), very crowded, arched, attenuated outwards, adnato-decurrent, permanently greenish yellow. The spores are purple brown in mass, pale lilac by transmitted light, oval, inequilateral, 6-8 × 3.5-4 μ. Two kinds of cystidia are present, (a) clavate, or ovate, or subcylindric, often contracted in the middle, 16-32 × 8-12 μ, with a thickened apex, sometimes with a minute apical point, and with yellow-brown contents ; (b) flask-shaped, hyaline, thin-walled, 16 × 8μ.

The fungus has not a bitter taste. The gills are of four lengths and very crowded, a pileus 2 cm. diameter having 32 gills extending from the stalk to the margin, and a total of 256.

The fungus has considerable resemblance to *Hypholoma fasciculare*, but its colours are slightly different, and it is much smaller and less

robust. At first sight it might be regarded as a small form of that species, but it apparently differs sufficiently in its adnato-decurrent gills. It also differs in habit, not being fasciculate, in having a mycelium which travels in the soil from the host stump, and in not being bitter to the taste. When grown on a stump in a pot under cover of a bell glass, the spores which fall to the ground, or on ferns, etc., growing round the stump, soon germinate, and form lilac grey, or purple grey, fluffy masses of spores and mycelium covering the soil.

Flammula Janus was described by Berkeley and Broome as "Caespitosus, sulfureus: pileo convexo obtuso umbonatove carnoso; stipite subaequali fistuloso glabro: lamellis angustis e subfusco ferrugineis (No. 759, cum icone). Caespitose, sulphur-coloured; pileus 0·75-1 inch across, convex, obtuse, or umbonate, slightly fleshy, flesh lemon-coloured; stem about an inch high, 1 line thick, curved, smooth, fistulose; gills very narrow, arched, slightly adnate: spores ·00025-·0003 long by ·00015-·0002 (inches)".

The description agrees fairly well with that of the fungus assigned to *Hypholoma fasciculare*. It was, of course, drawn up chiefly from the figures, but there is nothing on any of them to warrant the statement that the gills are "e subfusco ferrugineis."

All the specimens of Thwaites 759 in Herb. Peradeniya are the same species, and there is no doubt that *Flammula Janus* B. & Br. and *Hypholoma fasciculare* B. & Br. *non* Fr. are identical. It may be known as *Hypholoma Janus* (B. & Br.).

The specimens assigned to *Hypholoma fasciculare* by Berkeley from Gardner's collection (No. 45) appear from the figure to be the same species. But those assigned to *Hypholoma sublateritium* from the same collection (Gardner, No. 89) are more probably *Flammula rhodomala* (B. & Br.)

280.—Psathyra obtusata Fr.

In Fungi of Ceylon, No. 278, Berkeley and Broome recorded *Psathyra spadiceogrisea* Schaeff., from Thwaites 712***, 754, cum iconibus; and in Fungi of Ceylon, No. 279, *Psathyra obtusata* Fr., from Thwaites 711*, 712, 829, cum iconibus. On the paintings named by them, 711* and 829 are marked *Psathyra obtusata*, while 712, 754, and one marked by Thwaites 712 ter, 754, and 778, are all labelled with the alternative names *Psathyra spadiceogrisea* and *Psathyra obtusata*. Evidently Berkeley and Broome were in doubt about these identifications.

As noted in Ann. Perad., VI, p. 322, Berkeley and Broome included several species under each name. Nos. 712 and 754 are the species described there as *Psathyra reticulata*. No. 829 is not the same as No.

712 ; there were two figures of No. 829, which might very probably represent the same species, but one of them was named *Psathyra amaura*. No. 711* has now been identified, and it proves to be neither *Psathyra spadiceogrisea* nor *Psathyra obtusata*.

Specimens identical with Thwaites 711* have been collected at Peradeniya, growing on decaying palm nuts. The pileus is broadly conical or conico-convex, up to 2.2 cm. diameter and 1.3 cm. high, rufous when moist, becoming pale brownish grey or greyish brown, and when old, blackish grey with a yellow tinge, minutely atomate, smooth, faintly striate at the margin or, when wet, almost up to the centre ; flesh thin, fragile. The stalk is up to 4 cm. high, 2·5 mm. diameter, slightly attenuated towards the apex, white, smooth, shining, fragile, hollow, usually curved and tomentose at the base. The gills are moderately crowded, adnate, subventricose, outer ends acute, pallid becoming pale purple brown ; the edges bear cylindric or ovoid cystidia, 26-32 $\times$12-14μ, narrowed abruptly below into a short stalk, and numerous ovoid or subglobose cells, 20-24$\times$14-16μ. The spores are pale purple brown in mass, almost hyaline by transmitted light, oblong-oval, inequilateral, apiculus excentric, 6-9$\times$4-5μ.

This species has more crowded gills than *Psathyra obtusata* and is more regularly conical. It differs from *Psathyra spadiceogrisea* in shape and colour, and in the colour of the spores. It may be known as *Psathyra rufescens*. Type specimen and painting, No. 6560 in Herb. Peradeniya.

281.—**Psathyra efflorescens** B. & Br.

Psathyra lucipeta B. & Br.

Psathyra efflorescens was described by Berkeley and Broome in Fungi of Ceylon, No. 282, as " Gregarius ; pileo hemisphaerico materie saccharino obsito : stipite curvo tenui e strato tomentoso candido oriundo: lamellis adnatis. On dead mossy trunks. Peradeniya, Nov. 1867. Pileus $\frac{1}{4}$ inch across ; spores brown-purple, ·0003 long. Habit of *A. corticolor*." There are specimens and a painting in Herb. Peradeniya (Thwaites 712 bis, 754, 778).

Psathyra lucipeta was Fungi of Ceylon, No. 284. It was described as " Pileo subhemisphaerico pallide carneo estriato ; stipite curvo glabro fistuloso ; lamellis angustis ventricosis postice rotundatis adnatis (No. 895, cum icone). On dead sticks. Peradeniya, Jan. 1869. Gregarious ; pileus $\frac{1}{2}$ inch across, nearly hemispherical, white, tinged with pink, darker in the centre, margin slightly crenate ; stem 1 inch high, $\frac{1}{2}$ line thick, curved, of the same colour as the pileus, smooth, fistulose ; gills narrow, ventricose, rounded behind, adnate ; spores ovate ·0003-·0004 long."

These two are the same species, *Psathyra lucipeta* being the young, or the dry weather, form. In one instance, when the fungus developed round an *Areca* stump in a plant pot at the laboratory, the specimens were *P. lucipeta* when observed on the first day, and *P. efflorescens* the following morning. It is frequent on dead stumps or logs, especially on palm tissue, usually fasciculate, often in dense masses.

The pilei are at first broadly convex, smooth, atomate, with a few loose scattered fibrils, white with a pinkish or purplish tinge, and with a dark spot in the centre. They become almost plane, up to 2·5 cm. diam., ashy, with a purple tinge when moist, usually slightly ochraceous in the centre, minutely radially corrugated and reticulated from the centre to the margin. The margin is even, sometimes slightly striate when moist, rarely somewhat crenate. The flesh is white, comparatively stout. Berkeley and Broome gave the diameter of the pileus of *P. efflorescens* as $\frac{1}{4}$ inch, but the figures show pilei 2·4 cm. diameter.

The stalk is white, shining, fistulose, brittle, hollow, up to 3·5 cm. high, 2·5 mm. diameter, white strigose at the base. The gills are narrow, rounded behind, ventricose, moderately crowded, adnate, sometimes with a decurrent line, pale purple. The spores are bright purple brown in mass, pale purple brown to almost hyaline by transmitted light, broadly oval or slightly quadrangular, 5-7×3-5μ. The edge of the gills bears oval or subglobose cystidia, 14-18×10-12μ.

282.—**Psilocybe bullacea** (Bull.) Fr.

Agaricus (*Psilocybe*) *bullaceus* Bull. was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 277, from Thwaites 838, *cum icone*. They added the note, "The Ceylon specimens have a perfect ring, but the spores are the same as in the ringless specimens. The species evidently varies in this respect as regards European specimens."

This species grows on dung. The pileus is hemispherical or broadly convex, sometimes umbonate, up to 3·5 cm. diameter, bay brown or blackish brown when moist, becoming ashy or yellow brown or grey brown when dry, glabrous, striate at the margin to about one third the radius when moist, even when dry, slightly viscid, with a very thin separable pellicle. The flesh is thin, and usually thin over the stalk. The stalk is up to 4·5 cm. high, 2·5 mm. diameter, equal, white or brownish white or pale brown, shining, minutely longitudinally silky, hollow, furnished with a rather stout, usually rigid, horizontally-spreading ring at about two-thirds its height. The gills are pallid, then purple-brown, with a whitish edge, distant, strongly triangular with the lower edge usually markedly arcuate, adnate with a decurrent tooth, or decurrent, up to 1 cm. broad behind, usually with a subacute angle be-

tween the pileus and the stalk. The spores are violet, sometimes reddish purple, lemon-shaped, with a minute hyaline nipple at one or both ends, 11-15×7-9μ. The gills bear small cystidia, flask-shaped, about 24μ high, 8μ diameter below, 3μ above.

This closely resembles *Psilocybe bullacea* in its general appearance and its viscid separable pellicle. But its spores, judging from the published descriptions, are larger, and different in both colour and shape. The shouldered lemon shape is well marked. If the presence of a ring is a generic distinction, this species must be placed in *Stropharia*, and the shape of the spores agrees with that of other species in that genus. Accordingly, it may be known as *Stropharia pseudo-bullacea*.

In Cooke's figures of *Psilocybe bullacea*, Illustrations of British Fungi, No. 608, the large specimen and its longitudinal section (the two upper figures on the left) are apparently taken from the Ceylon figures, Thwaites 838 of Dec. 24, 1868. The colour is much brighter than in the original painting, but the shape and stature are the same. Cooke, however, modified the figures by omitting the ring on the figure of the whole fungus, and making the gills in the longitudinal section less decurrent; or it may be that the alterations were made by Berkeley's copyist. In the longitudinal section, the flesh over the stalk is depicted thicker than usual, and the angle between the pileus and the stalk more rounded, but in these respects the copy faithfully reproduces the original painting.

283.—Panus coriaceus B. & Br.

In Fungi of Ceylon, No. 421, Berkeley and Broome described this species as "Pileo dimidiato subreniformi coriaceo rufo zonato, postice velutino, antice lineato rugoso, margine tenui crenato; lamellis ventricosis pallidis (No. 1124). On dead wood. Central Province, Feb. 1869. Pileus 1-2 inches across, coriaceous, zoned, of a rich red brown, velvety behind, marked in front with minute raised lines which sometimes form reticulations: gills pallid, spinulose." In Saccardo, Sylloge, V, p. 628, the name was changed to *Panus Berkeleyi* Sacc. & Cub., because of the prior existence of *Panus coriaceus* Berk. from Australia.

I have only met with this species once, and then neglected to gather much, being completely misled by its appearance in the field. It grew on the lower surface and sides of a prostrate log, in long resupinate patches up to a foot in width, from the margin of which there arose dimidiate, flabelliform pilei up to 4 cm. long. When fresh, it was cream or pale yellow, with a general resemblance to *Daedalea flavida*, but softer. The resupinate part was covered with large pores, irregular or hexagonal, 1-2 mm. in diameter, and 5 mm. deep. Towards the margin, the pores become larger and elongated, and on the flabelliform pilei

they give place to parallel gills, which may unite into pores at the acute margin.

The colour and texture of the dried specimens are quite different from those of the fresh specimen. The fungus becomes brownish yellow, zoned concentrically with narrow red brown bands, and finally dark red brown with purple brown bands, or wholly purple brown. It loses its tomentose appearance, and becomes hard and horny, radially ridged, and sometimes with minute anastomosing ridges in addition.

As noted by Berkeley the gills are spinulose, with erect, rigid spines consisting of fascicles of hyphae.

Mr. Lloyd kindly pointed out to me several years ago, that this species had been distributed from the Philippines as *Elmeria cladophora* (Berk.) Bres. The specimen of the latter in Herb. Peradeniya is Bureau of Science, 4213 : it has longer pilei and narrower gills than the Ceylon form, and is not concentrically zoned.

The genus *Elmeria* was proposed by Bresadola in Hedwigia, LI (1911), p. 317, the name being changed by him to *Elmerina* in Ann. Myc., X (1912), p. 507. The genus was established on *Hexagonia cladophora* Berk. and *H. vespacea* Pers., and subsequently Bresadola transferred to it *Poria setulosa* P. Henn.

That *Panus coriaceus* is not a good *Panus* is self-evident. If the genus *Elmerina* is retained, this species will stand as *Elmerina Berkeleyi* (Sacc. & Cub.). It is, however, doubtful whether a genus can be maintained solely on this character of the setae, as it will include species which are widely different in other respects.

284.—**Polystictus zeylanicus** Berk.

In "A preliminary list of Ceylon Polypori" (Ann. Perad., VI, pp. 87-144), I stated that *Polyporus zeylanicus* Berk. required comparison with *Hexagonia pergamenea* B. & Br., since specimens from the Philippines which were identical with *Polyporus zeylanicus* had been distributed as *Polystictus pergameneus* (Berk.) Bres. I have not been able to find any publication of the latter name. Subsequently Mr. C. G. Lloyd (*in litt.*) informed me that in his opinion *Polyporus zeylanicus* Berk. was identical with *Polyporus Peradeniae* B. & Br.

During my recent leave in England, I re-examined the type specimens of *Polyporus zeylanicus* and allied species from Ceylon, and have come to the conclusion that *Polyporus zeylanicus* Berk., *Polyporus Peradeniae* B. & Br., *Polyporus personatus* B. & Br., *Polyporus diversiporus* B. & Br., and *Hexagonia pergamenea* B. & Br. are all the same species. It appears to be identical with *Polyporus cervino-gilvus* Jungh. from Java, while from the Philippines it was named *Trametes dermatodes* by Léveillé.

None of these names was included by Bresadola and Sydow in their Enumeration of Philippine Basidiomycetes in Philippine Journal of Science, IX C., p. 345 (1914). Graff, in Philippine Basidiomycetes II, Philippine Jour. Sci. IX C, p. 239, lists *Polystictus cervino-gilvus* (Jungh.) Fr., with the synonyms, *Trametes dermatodes* Lév. and *Polyporus Peradeniae* B. & Br.

Polyporus zeylanicus was collected in Ceylon by König, and described by Berkeley in "Notices of Fungi in the Herbarium of the British Museum" (Ann. Nat. Hist., X (1842), pp. 369-384). The type specimen is in the British Museum (Natural History). The fungus is orbicular, plane, thin but rigid, up to 1·75 mm. thick, the context 0·6-0·8 mm. thick and the pores 0·4-1·2 mm. deep. The colour is brown or tawny brown, and the surface is rough with radial raised ridges or bands of hyphae, sometimes broken into coarse sub-erect fibrils. Between the ridges it is glabrous and shining. The pore surface is slightly darker, with a sterile zone at the margin, followed by oval, developing pores 0·3-0·4 mm. diameter, but further back the pores are up to 0·9 × 0·5 mm., more or less elongated. The dissepiments are up to 0·06 mm. thick, woolly or tomentose, and somewhat produced at the angles. The interior of the pores is ashy, but the hymenium is undeveloped, and no cystidia were found. The context consists of hyphae, 3-6μ diameter, yellow-brown in mass, pale yellow when isolated, many of them solid: there are numerous yellow-brown, globose, spore-like bodies, 4μ diameter, in the context. This species was not recognised again by Berkeley in Gardner's or Thwaites's collections.

Hexagonia pergamenea was described from specimens sent to Berkeley by Thwaites in 1851 and 1854, but the name was not published until 1873, in Fungi of Ceylon, No. 526. The two specimens, now in Herb. Kew, appear to be the same species. The sheet has been recently marked *Polystictus Berkeleyi* Bres., a name which was published in Ann. Myc., XIV, p. 231. They are resupinate, with a narrow free margin. The pore surface is pale brownish white. The developing pores near the margin are 1-2 mm. diameter, while further back they are oval, up to 2 × 1 mm., or forming long lines, 6 mm. or more long and 1 mm. wide, with lower cross walls. The dissepiments are thick and woolly. The margin is flat, thin, and rigid. The upper surface is tawny brown, with radially arranged superficial fibres, not so strongly developed as in *P. zeylanicus* and tending to become matted tomentose. The context is the same as in *P. zeylanicus*. The hymenium is undeveloped, and no cystidia were found.

Polyporus Peradeniae was described by Berkeley and Broome from Thwaites 221 in Fungi of Ceylon, No. 478. They stated that the

hymenium varied from flesh colour to yellowish olive. The specimens are resupinate, with a free lobed margin up to 2 cms. broad, extending laterally for several inches. The free part is thin, flexible and rather soft. The pore surface is pale yellowish brown with more or less hexagonal pores, 0·3-0·5 mm. diameter in front and up to 1 mm. diameter behind. The dissepiments are thin and produced at the angles. The hymenium bears hyaline cystidia, cylindric, tapering upwards, 25×5-8μ, sometimes slightly inflated below. The upper surface is silky tomentose, with adpressed hyphae arranged more or less in broad, close-set, radial fascicles. The context is the same as in *P. zeylanicus*.

Polyporus personatus was described by Berkeley and Broome in Fungi of Ceylon 479, from Thwaites 133, 535. There are specimens in Herb. Kew and Herb. Peradeniya. Berkeley and Broome described it as dimidiate, sometimes attenuated behind and fixed by the vertex. In the type specimens and in recent collections, it is variable in that respect. In some parts, it may be resupinate with a broad free margin exactly as in *P. Peradeniae* ; in other parts of the same gathering, the free margin takes the form of flabelliform or orbicular pilei attached by a narrow base ; while elsewhere there may be no effused resupinate part, but only dimidiate pilei attached over a small dorsal area.

In the type specimens of *P. personatus*, the pores are more or less hexagonal, 0·8-1·2 mm. diameter, or 0·5-0·8×0·9-1·2 mm., or forming long lines on the resupinate part. The dissepiments are thin, and frequently produced at the angles. The sterile margin is wanting. Fresh specimens are salmon pink on the under surface ; Berkeley and Broome described the hymenium as flesh-coloured to pale tawny. The upper surface is tawny brown or yellow brown, often with a yellow margin ; it is matted tomentose, with a slight radial arrangement of the hyphae, obscurely concentrically sulcate. The context is the same as that of *P. zeylanicus*. The hymenium bears hyaline cystidia, usually strongly encrusted above, either ovate, 12×7 μ, or ovate with a solid conical or cylindrical tip, 18×8 μ, in the type specimens. In a recent collection the cystidia are ovate or flask-shaped, 25×9μ.

Professor S. R. Bose has shown me specimens from India which are *P. personatus* in their dimidiate, dorsally affixed shape, but have the upper surface covered with erect coarse hyphae to a much greater extent than in the type of *P. zeylanicus*.

Polyporus diversiporus was described by Berkeley and Broome in Fungi of Ceylon, No. 491, from Thwaites 535 (in part). The type in Herb. Kew contains two species, *P. diversiporus* and *P. Peradeniae*. *P. diversiporus* is resupinate with a narrow free border. Its pores towards the margin are more or less circular, 0·4-1 mm. diameter, or oval, 0·7-

0·8×0·8-1 mm.; further back they may be 2 mm. long and 0·6 mm. wide, tending to an arrangement in long lines. The dissepiments are thick and tomentose, and the fungus appears stouter than the usual forms of *P. Peradeniae*. The hymenium is undeveloped, and no cystidia were found. The upper surface is matted tomentose with an obscure radial arrangement. In some places there is an almost glabrous zone bordering the line of attachment.

The differences between the various specimens are chiefly differences of development. At first the dissepiments are thick and tomentose, but they become thin as the pores lengthen. When the hymenium is fully developed the colour changes from yellow or yellow-brown to salmon pink. In the commoner forms the upper surface is clothed with adpressed, somewhat silky hyphae, arranged more or less in radial fascicles, but in the form named *Polystictus zeylanicus*, the hyphae form coarse fibrils which curve upwards and become suberect.

The specimens from the Philippines which Bresadola referred to *Polystictus pergameneus* (Berk.) Bres. *i.e. Hexagonia pergamenea* B. & Br., are clearly identical with *Polystictus zeylanicus*. Lloyd holds that *Polyporus Peradeniae* and *Hexagonia pergamenea* are identical with *P. zeylanicus*. Graff includes *Trametes dermatodes* and *P. Peradeniae* as synonyms of *Polyporus cervino-gilvus* Jungh. To the latter may now be added *P. diversiporus* B. & Br., *P. personatus* B. & Br., *P. zeylanicus* Berk., and *Hexagonia pergamenea* B. & Br.

The selection of the name *Polystictus Berkeleyi* Bres. for this species was unfortunate, as liable to confusion with *Polyporus Berkeleyi* Fr.; and the possibility of confusion is increased by the fact that *Polystictus Berkeleyi* Bres. is synonymous with *Polyporus zeylanicus* Berk., while *Polyporus Berkeleyi* Fr. is synonymous with *Polyporus Zealandicus* Cooke.

It is of interest to note that Thwaites 133 provided *Polyporus personatus*, and Thwaites 535, *Polyporus personatus*, *P. diversiporus*, and *P. melleus*. In Herb. Kew, *Polyporus personatus*, Thwaites 133, 535, are on the same sheet and there is no distinguishing mark ; similarly the type of *Poria mellea* is marked 133, 535. In Herb. Peradeniya, Thwaites put all his duplicates of 133, 535 together, adding another number, 650, *P. variolosus*, and the specimens consist of three pieces referable to *P. diversiporus*, one of *P. personatus*, and two of *P. variolosus*. Evidently Thwaites considered that all these were the same species. *Poria variolosa* and *Poria mellea*, however, appear to be distinct from *Polystictus cervino-gilvus*.

Mr. C. G. Lloyd, to whom I submitted parts of the original collections of *P. diversiporus* and *P. personatus*, with recent collections

of the same species, informs me that he would consider them all forms of *P. cervino-gilvus*. Mr. Lloyd, however, holds that there are two species in the group which I have considered as one in this note, viz.,

1. *P. zeylanicus* Berk.; syn., *P. Peradeniae* B. & Br., *Hexagonia pergamenea* B. & Br.
2. *P. cervino-gilvus* Jungh.; syn., *Trametes dermatodes* Lév., *P. personatus* B. & Br., *P. diversiporus* B. & Br.

The distinction between these two would appear to lie in the character of the upper surface of the pileus. In *P. cervino-gilvus*, the tomentose covering of the pileus consists of silky hyphae, usually arranged in flat, more or less radial fascicles, but sometimes without definite arrangement. In *P. zeylanicus*, the hyphae are agglutinated into radial ridges, usually rough with recurved or suberect fibrils, and the spaces between the ridges may be glabrous. But on this character, it would seem that *P. Peradeniae* should be referred to *P. cervino-gilvus*, while *Hexagonia pergamenea* is intermediate. I would prefer to regard the more scabrid forms (*P. zeylanicus*) as probably climatic forms of *P. cervino-gilvus*; they appear to be rare in Ceylon.

285.—Polyporus epilinteus B. & Br.

In Mycologia, XIII, p. 84, Murrill refers *Polyporus epilinteus* B. & Br. to *Poria vincta* (Berk.) Cooke, and states that, according to Cooke, one of the original type specimens of *Polyporus epilinteus* has orange mycelium while the two others are without it.

I have not met with Cooke's statement, but, of the three specimens in the type of *P. epilinteus*, one is *Polyporus Kermes* B. & Br., and the other two *Polyporus zonalis* Berk., as recorded in Ann. Perad., VI., p. 105.

286.—Hexagonia velutina Pat. & Har.

In Synopsis of the Genus Hexagona, Lloyd records (p. 14) that a collection of *Hexagonia velutina* reached Berkeley from Ceylon and was referred by him to *Hexagonia variegata*. Apparently the record was never published by Berkeley.

The specimens in question are in the cover of *Hexagonia variegata* in Herb. Kew. The sheet is marked "Ceylon" only. It is not named by Berkeley, and, contrary to the usual practice with regard to Ceylon specimens, it bears neither date, locality, collection number, nor collector's name. The specimens appear to be part of the same gathering as those in another cover marked *Hexagonia membranacea* by Cooke, a name which apparently was not published.

In view of the lack of data on the herbarium sheet, and the fact that nothing resembling this species was recorded for Ceylon by Berkeley

or has been collected since, it would seem advisable to consider the statement that the specimens were collected in Ceylon as possibly incorrect.

287.—Cladoderris Thwaitesii B. & Br.

Cladoderris Thwaitesii was described by Berkeley and Broome in Fungi of Ceylon, No. 571, as "Minor, erecta, spathulata, extus glabrescens ; stipite subcylindrico compresso radicante (No. 1003). Peradeniya, Nov. 1868. About 2 inches high with the stem, 1¼ (inches) across at the top, becoming dark brown above ; hymenium pale rufous, distinctly veined." Specimens in Herb. Kew and Herb. Peradeniya have been examined.

This species is fairly frequent in decaying clumps of the Giant Bamboo (*Dendrocalamus giganteus*), but its growth appears to be arrested in very many cases at an early stage, and the fully-developed pilei are rare.

The pilei are cuneate to flabelliform, up to 6 cm. high, lobed and incised above, up to 4 cm. broad, usually shortly stalked, but sometimes with a rooting base up to 5 cms. long. In general they occur in clusters, arising from a common base, but they may be scattered, and in the latter case they frequently have a long rooting base embedded among the bamboo roots. The pilei stand erect, or suberect, with the lateral edges recurved, in rosettes after the manner of *Stereum elegans*, often with the pilei confluent above. The clusters are, however, taller than those of the latter species, and they have quite a different appearance.

The upper surface of the pileus is pale buff, or pale ochraceous, with a white margin, sometimes obscurely zoned towards the margin, sometimes wholly white ; it is minutely tomentose, and radially (longitudinally) ridged. The stalk is white and tomentose. The hymenium is pale purple-grey at first, becoming cinnamon brown, and is usually slightly radially ridged or folded. The substance of the pileus is white, somewhat brittle when fresh, but tough when dry, fibrillose, not cartilaginous.

When bruised, the hymenium turns dark red, this colour rapidly changing to dark purple brown or chocolate brown. The context undergoes the same colour change when cut.

The basidia are 5μ diameter, four-spored, with slender sterigmata up to 8μ long. The spores are hyaline, globose, smooth, 5-8 μ diameter. Cystidia were not found.

This species is a *Stereum*, and will stand as *Stereum Thwaitesii*. The folds or ridges on the hymenium appear more prominent on the dry, than on the fresh specimens, owing to their discoloration when the specimens are pressed.

288.—Peniophora Habgallae (B. & Br.) Cooke.

Berkeley and Broome described this species in Fungi of Ceylon, No. 645, as *Corticium Habgallae*, "suborbiculare ceraceum ochroleucum, margine tenui tomentoso uno latere elevato ; hymenio subtiliter setuloso (No. 339). On dead bark. Habgalla." Cooke, in Grevillea, VIII, p. 20, transferred it to *Peniophora*, stating that the cystidia (metuloids) were narrowly fusiform, attenuated and smooth above, 70-80 × 12·5μ. Massee, in Jour. Linn. Soc., XXV, p. 142, repeated Berkeley and Broome's description, adding that the cystidia were fusoid, 60-70 × 12μ, and the spores subglobose, 5-6μ. Massee stated that the fungus formed "more or less elliptical patches about 1 in. long by ½ in. wide, and in every instance with a tendency to become reflexed on one side, thus forming a transition from the truly resupinate to the reflexed species." The name of the locality should have been Hakgala.

The fungus is common at Hakgala on dead branches of *Cinnamomum Camphora*. It is pezizoid, circular or oval, regular or somewhat lobed, up to 1·5 cm. diameter. The upper surface is plane or undulating, with a sharp definite margin, from which the convex sides curve backwards slightly into the flat base, which is attached to the host plant only over a central area. When fresh, the fungus is up to 3 mm. thick, but it contracts to a disc, 0·5-1 mm. thick, on drying. The fresh specimens are fragile, with a fleshy cortex and hymenial layer, but subgelatinous internally ; the colour of the hymenium is white, or pallid with a white margin, while the lower surface is white. The hymenial layer is about 0·15 mm. thick, and the cortex at the base and sides 0·1 mm. thick. The cystidia are hyaline, flask-shaped or conical, encrusted, wall slightly thickened, 80-100 μ high, 14-20 μ diameter below. The spores are oval, smooth, hyaline, 16-21 × 12-14 μ. The lower surface is slightly tomentose towards the margin, and it becomes concentrically grooved in drying.

The "uno latere elevato" of the original description was probably an accident of growth, or a distortion in drying.

289.—Kneiffia gelatinosa B. & C.

This was described by Berkeley in Cuban Fungi, No. 363, as "Effusa, arctissime adherens, venosa, gelatinosa, pallida, papillis minutis farinosa. Resembling *Phlebia* in habit ; but the minute papillae, which have frequently little setiform appendages at their apices, bring it under *Kneiffia*. It may perhaps form a distinct genus, when *Hydnum gelatinosum* is separated." In Fungi of Ceylon, No. 569, Berkeley and Broome recorded the same species from Ceylon. Patouillard, Bull. Soc. Myc. France, VIII, p. 120, transferred it to *Heterochaete*, stating that the basidia

were claviform, 30×15 μ, two to four septate, the spores elongated oval, 20-25×8-10 μ, the promycelium short, 10-15 μ, and the conidia subglobose, 10 μ.

The Ceylon specimen, Thwaites 602, is resupinate, livid grey, horny, about 0·1 mm. thick, covered with short processes, which are conical, or cylindric, sometimes expanding above, sometimes flat topped, up to 0·1 mm. high and 50 to 150 μ diameter at the base. It is compact, with a thin yellow-brown basal layer, the remainder being hyaline and translucent, containing numerous, large, irregularly oval masses of calcium oxalate, up to 24×20 μ. The hymenium is continuous over the processes, and contains conical, hyaline, encrusted cystidia, 24-30 μ high, 8-10 μ diameter, projecting 16 to 20 μ, which are scattered over the flat surface, but clustered on the apices of the processes. The basidia are cylindric, 4 μ, diameter, with four short sterigmata.

The Ceylon species is not *Heterochaete*. The cystidia are those of a *Peniophora*, while the processes are those of *Odontia*. It is not *Scopuloides* of Massee, as the processes are not merely clusters of cystidia. It may may stand as *Odontia pallida*, nom. nov.

290.—Kneiffia discolor B. & Br.

Berkeley and Broome described this in Fungi of Ceylon, No. 564, as "Tenuis, submembranacea, lobata, margine angustissimo, lactea, granulis rufis. Spread over the bark. The edge sometimes free."

This species is not uncommon at Peradeniya. It is resupinate, adnate, effused, with a byssoid margin at first. When old, the margin becomes solid and may recurve slightly in drying. When fresh, it is lilac, with a white margin, becoming white when old. It bears numerous clavate or conical processes, up to 50 μ diameter below, projecting about 60 μ above the surface. Between the processes the hymenium is smooth or minutely pruinose. The total thickness of the fructification varies from 0·1-0·2 mm., and it differs considerably in structure from point to point. In general, the lower part is yellow-brown, composed of agglutinated hyphae, more or less parallel to the substratum ,with a hyaline upper layer about 60 μ thick. The processes, which are composed of parallel hyphae and are red-brown or yellow-brown by transmitted light, arise from the yellow-brown stratum. Where the stroma is thicker, the yellow-brown stratum divides into two, one part overlying the substratum and the other lying below the upper hyaline layer, the intermediate tissue being hyaline ; and the processes then arise from the upper yellow-brown layer. The intermediate hyaline tissue may consist either of more or less parallel hyphae like the basal layer, or of loosely interwoven hyphae. Where the stroma is very thin, the yellow-

brown basal layer is almost lacking, and the processes appear to arise from the substratum. Developing processes, within the context, are covered by masses of calcium oxalate, and these remain round the bases of the fully-developed processes. The hymenium contains somewhat irregular tubes, which stain more deeply with iodine than the remainder of the hymenium and appear to be gloeocystidia. The basidia are those of *Heterochaete*, and the species must stand as *Heterochaete discolor* (B. & Br.). Its spores are hyaline, oval, inequilateral, 8-10 × 5-7 μ.

Heterochaete tenuicula (Lév.) differs in its definite stroma, separable from the substratum, and in colour when fresh.

291.—Kneiffia coriacea B. & Br.

Berkeley and Broome described this species as "Crassa, rigida, secernibilis, hymenio pallide umbrino granulis albis sparso, margine lato fusco. 4 inches across; margin barren."

The specimen in Herb. Peradeniya, Thwaites 991, is about 7 cm. broad, and evidently extended for at least double that length. It is livid grey, with small white spots, and a broad, glabrous, black, or here and there reddish-brown, margin. It is separable from the substratum, and apparently sometimes free towards the margin. The lower surface is black, strigose or tomentose with rufous-brown tomentum, united to the substratum at several points and often concentrically zoned round the points of attachment. The fructification is rigid, and up to 1 mm. thick, the surface cracking on drying (?). The section viewed macroscopically shows yellow-brown hyphae below, then a dense, black, horny basal layer, followed by a dark rufous-brown layer for about half the thickness of the stroma, and an upper, more purple-brown layer of about the same thickness, mottled with white.

By transmitted light, the sub-basal hyphae are yellow-brown, regular, thick-walled or solid, up to 5 μ diameter, and form a loose weft up to 0·1 mm. thick. The basal layer is red-brown, about 0·15 mm. thick. The tissue above this, for about 0·3 mm., is pale yellow-brown, and composed of fused hyphae, more or less parallel to the substratum as in the basal layer. This merges into an upper layer, about 0·4 mm. thick, yellow-brown below, becoming hyaline above, stratose, of vertically parallel, fused hyphae, etc. The specimen shows three successive hymenia. The whole section is sub-translucent. The hymenium contains numerous gloeocystidia with red-brown contents (in the dry specimen); these are very slender, 1-2 μ diameter, below, with long clavate tips, 4-5 μ diameter. Scattered through the old hymenia are masses of crystals of calcium oxalate; these give the mottled appearance when the fungus is cut. In the current hymenium, these masses occupy cavities,

up to 100 μ deep and 100 μ diameter, open above ; the masses may project 20 μ above the surface, and they form the white dots. These masses do not fall out, but are buried by the subsequent growth of another hymenium. The basidia are 6 μ diameter, clavate, somewhat attenuated above ; the spores are hyaline, oval, inequilateral, acute at the ends, 5 × 3μ.

This species is a *Stereum* (*Lloydella*), and will stand as *Stereum* (*Lloydella*) *coriaceum* (B. & Br.).

292.—Kneiffia insularis B. & Br.

Berkeley and Broome's description of this species is "Tenuis, sparsa, irregularis, immarginata, lobata ; hymenio centro subumbrino ; granulis minutis." They added, "There is also what we suppose to be a younger state, in which the plant is white, with a pinkish-grey tinge in the centre."

The specimen in Herb. Peradeniya is effused, in small, irregularly lobed patches, cream-coloured or pale ochraceous, pulverulent or byssoid, covered with minute processes. Sections show that the fungus is a mere film, sometimes up to 20 μ thick, sometimes barely covering the substratum. The processes are cylindric, up to 40 μ high, 20μ diameter, or irregularly globose, 50 μ diameter, or pulvinate masses partly embedded in the film. The context is composed of hyaline irregular hyphae, 1-2 μ diameter. The globose processes are superficial, and are masses of calcium oxalate bound together by a few hyphae ; on treatment with hydrochloric acid they disappear. The cylindrical processes, which are embedded in the film, are also composed largely of masses of calcium oxalate, but in some cases a loose column of hyphae is left after treatment with hydrochloric acid. The film contains ovoid basidia, 4 × 3 μ, in small clusters. The specimen is scarcely in a fit condition for determination, but it would appear to be a *Corticium*. The structure of the processes is not definite enough to decide its position.

The white species referred to by Berkeley and Broome is entirely different. It forms small, chalky-white, more or less circular patches, with scattered, minute, rounded elevations, about 0·1 mm. diameter. Where it is rubbed, it appears brown. It is about 0·2 mm. thick, with two well-defined layers, which readily separate from one another. The lower layer, about three-quarters of the thickness of the stroma, is composed of densely interwoven, yellow-brown hyphae, 2 μ diameter, not fused. The upper layer is hyaline, composed of irregularly flexuose hyphae, 2 μ diameter, bearing numerous branches which form, either short spines, or long slender hyphae 1 μ diameter, with minute, oval lateral conidia, 2·5 × 1·5 μ. It is not possible to decide what this is from this specimen, and it is doubtful whether it consists of one or of two fungi.

293.—Kneiffia chromoplumbea B. & Br.

This was described as "Luteo-fulva, margine tenui pulverulento byssoideo flavo ; hymenio granulato, setulis albis. Varying from chrome yellow to tawny. In one specimen, if really the same, the margin is white. It appears to turn brown when old."

From the specimen in Herb. Peradeniya (Thwaites 606), the fructification begins as an effused, bright chrome yellow patch, which acquires a thin, waxy or subgelatinous upper layer, and becomes rough with pulvinate tubercles, 0·2-1 mm. diameter, or irregular ridges ; some of these are due to irregularities in the substratum, but the majority are true variations in the thickness of the stroma. It appears to be densely covered, both on the flat and the elevated parts, with white cystidia, 0·1 mm. high, scattered or clustered, up to 40 μ diameter, usually clavate. These, however, are not true cystidia ; they consist of overlapping, more or less tabular masses of calcium oxalate, adherent to conical or cylindric processes, which are composed of parallel hyphae, compact, like the processes of a *Heterochaete*.

The fructification is up to 0·2 mm. thick in the flat parts, increasing to 0·5 mm. in the tubercles. In section the basal layer is red-brown, about 30 μ thick, and composed of agglutinated hyphae parallel to the substratum. The intermediate tissue is pale yellow, hyaline in thin sections, rather loose, and composed of slender interwoven hyphae. The hymenial layer is red-brown and somewhat horny in section, viewed as an opaque object, but translucent in thin sections. The upper part of the fructification contains numerous gloeocystidia with greenish-yellow contents ; these are narrow-oval, sometimes produced into a point above, 16-24 × 7-8 μ, with a slender stalk, 2 μ diameter ; they are situated at various depths and rarely reach the surface. The basidia are 6 μ diameter, four-spored.

Alcohol extracts a resinous or oily substance, which forms minute globules in water. On treatment with lactic acid, some parts of the pseudocystidia, and perhaps part of the contents of the gloeocystidia, dissolve, and the dissolved substance crystallises out again on the slide in radiating groups of long, greenish-yellow needles. These needle-shaped crystals do not dissolve in hydrochloric acid. Treatment with hydrochloric acid dissolves the tabular crystals on the pseudocystidia.

If a section is treated first with lactic acid and then with hydrochloric acid, the processes which form the foundation of the pseudocystidia are left free of any adhering substances, except some of the recently-formed needles. But if the section is treated first with hydrochloric acid, and the calcium oxalate masses dissolved, irregular masses of a greenish-yellow resinous substance remain adherent to the processes, and

subsequent treatment with lactic acid does not dissolve these or induce the formation of any needle-shaped crystals.

The combination of characters in this species makes its systematic position doubtful. For the present, I leave it under Berkeley and Broome's name, as it would appear to be equally out of place in any other established genus.

There is a single fragment of another species in Thwaites 606 in Herb. Peradeniya, apparently an immature *Asterostromella*. The Peradeniya specimen has not a white margin.

294.—Kneiffia isabellina B. & Br.

Berkeley and Broome's description of this species is "Tenuis, late effusa, margine tenuissimo pulverulento quandoque elevato ; hymenio isabellino, granulis minutissimis. Spreading far and wide ; surface continuous, of a delicate pinkish grey, covered with extremely minute granules."

Thwaites included under No. 655, a collection made in the Southern Province, July 1868, and another made in the Central Province, December 1868 ; and Berkeley and Broome cited both these as *Kneiffia isabellina*. In Thwaites 655 in Herb. Peradeniya, there are undoubtedly three collections, on different substrata.

The largest specimen, which is thin and widely effused, is pale brownish ochraceous, with a narrow, smooth, brown margin. The stroma is cracked near, and parallel to, the margin, which is not elevated in this specimen. The general surface is even, rough with minute, close-set granules arranged in irregular rows. The fructification is 0·3 mm. thick, internally pale-brown, mottled with white, when viewed as an opaque object. In sections by transmitted light, there is a very thin, yellow-brown, basal layer, scarcely differentiated from the remainder of the stroma. The context is pale yellow-brown or hyaline, somewhat in patches, and is composed of densely interwoven, agglutinated slender hyphae. It includes irregular, sub-cylindric masses of calcium oxalate, up to 0.2 mm. long and 50 μ diameter. These give the mottled appearance seen in section. Some of these masses are entirely immersed ; others reach the surface, and project up to 30 μ, forming the granules seen on the hymenium. Basidia have not been observed.

Another collection is represented by several small pieces. It was probably widely effused. The colour is slightly paler than that of the foregoing, and its surface is undulating. It has the same arrangement of granules. The margin differs, being narrow, of the same colour as the remainder of the fructification, tomentose, thick, and tending to separate from the substratum. The fructification is up to 1 mm. thick,

stratose, in two layers, the lower layer being about two-thirds the entire thickness. There is no marked basal layer. The context is the same as in the first collection, and it contains similar masses of calcium oxalate, up to 0·3 mm. long. The projecting ends of these masses are sometimes surrounded by a narrow up-growth of hyphae.

The third collection is effused, purple-grey, and has cracked into small areolae, exposing the inner tissue, which appears white in the cracks. It bears numerous projections, up to 75 μ high, either conical, up to 100 μ diameter at the base, or cylindric, up to 50 μ diameter. The fructification is 0.25 mm. thick, the internal tissue being yellow-brown to hyaline, rather compact, composed of slender irregular hyphae, sometimes agglutinated, sometimes loosely interwoven, without a differentiated basal layer, and containing large numbers of subglobose granules of calcium oxalate. The surface of the stroma, and the processes, are covered with similar granules, often resembling sphaerocrystals. After removal of the calcium oxalate with hydrochloric acid, the processes are found to consist of rather loose, more or less erect hyphae. Basidia have not been found.

The third specimen is perhaps an *Odontia*. The other two would appear to be identical with one another. Berkeley and Broome's description would fit the latter two together, but neither of them separately. But the only specimen which looks as if it could ever have been pinkish grey is the third. The first and second collection are probably a *Corticium*. but any change of name must be deferred until the type specimen in Herb. Kew has been examined.

295.—**Kneiffia Muelleri** Berk.

Grandinia papulosa B. & Br.

Kneiffia Muelleri was originally described by Berkeley from Australia in Jour. Linn. Soc., XIII, p. 167, as "Tota resupinata tenuis, junior farinulenta, senior continua hic illic rimosa granulis perithecii-formibus apice niveis. When the granules have fallen off, it looks like a *Porothelium*." It was recorded for Ceylon by Berkeley and Broome, with the note, "This very curious species is at once distinguished by the granules falling out and leaving little holes. The Ceylon specimens seem the same with those from Australia, but are of a purer white."

The specimen (660) which Thwaites retained in Herb. Peradeniya is pale yellow, effused, thin, even, 50-100 μ, thick, closely studded with circular holes, 0·1-0·3 mm. diameter, sometimes confluent in short branching lines, which appear to expose the substratum. In some of these holes there is a minute white mass in the centre, united to the sides by fine, radial strands. At one side of the specimen the margin is chiefly

white and byssoid. At the other side there are waxy, pale ochraceous patches, which bear minute, paler, circular areas ; and on examination under a low magnification it is seen that on these pale spots the surface layer is raised and cracked, and finally recurves, forming a crater-like cavity. These are the first stages of formation of the holes in the stroma. When fully formed, the margins of the holes are smooth and do not indicate the mode of origin.

The context is composed of loosely interwoven, hyaline hyphae, enclosing large numbers of granules of calcium oxalate, and has a thin, pale yellow, surface layer about 12 μ thick. It contains numerous cavities, which extend almost from the base to the upper layer of the fructification, and are filled with granules of calcium oxalate. The upper layer overlying a cavity breaks up and disappears ; and the granules fall out, leaving a hole which descends almost to the base of the stroma. In some cases, a small mass of granules, bound together by hyphae, persists in the centre of the cavity. Basidia have not been observed in this specimen.

In Fungi of Ceylon, No. 559, Berkeley and Broome described *Grandinia papulosa* B. & Br., as " Effusa, ochroleuca, margine angustissimo vel obsoleto ; hymenio glabro papulis obtusis depressis, interstitiis laevibus. Spreading for some inches. Hymenium sprinkled with scattered depressed granules."

There are three pieces of this in Thwaites 995 in Herb. Peradeniya, bearing examples of the fungus which differ in thickness. The smallest and youngest patch, only about 2 cms. long, is exactly the same as the Peradeniya specimen of *Kneiffia Muelleri*. Another thicker piece, up to 0·15 mm. thick, is covered with scattered minute elevations and small white masses ; this again has the same structure as the specimen of *Kneiffia Muelleri*, the white masses of granules descending almost to the base, and the minute elevations being points where the upper layer has not broken away. The third and largest piece evidently extended for several inches ; it is cream-coloured (?) without a differentiated margin, or with a narrow, brown, glabrous margin, and covered with flattened-pulvinate, white masses, up to 0·4 mm. diameter ; it is up to 0·5 mm. thick, stratose, the old hymenia appearing as pale yellow and translucent zones in thick sections ; the structure is that of " *Kneiffia Muelleri*," the masses of granules descending almost to the base of the stroma. In the thicker stromata, the granules have not fallen out.

Berkeley and Broome stated that the granules were depressed. The masses are more or less flat-topped, and tend to spread out in lobes over the surrounding hymenium. In some instances, the part of the superficial layer which originally covered one persists as a minute brown cap.

The thicker fructifications have minute, hyaline, rough cystidia, obtuse, cylindrical above, suddenly attenuated below, 12-14 μ long, 5-6 μ diameter, projecting 8-20 μ, and only slightly embedded. The basidia are clavate, 4 μ diameter, with slender sterigmata 2 μ long. Cystidia have not been found in the young, thin examples.

The masses of granules which appear as white spots on the hymenium are similar to those of *Kneiffia coriacea*. They would not appear to constitute a generic character. *Grandinia papulosa* is identical with the Ceylon specimen of *Kneiffia Muelleri*, and is a *Peniophora*. The Australian type specimen of *Kneiffia Muelleri* has not been examined, and hence it is not yet possible to make any statement regarding it, or to settle the name of the Ceylon species. From Berkeley's description the Australian fungus would appear to be different.

296.—Kneiffia setigera Fr.

Berkeley and Broome recorded this species for Ceylon from Thwaites 654. There are two different species in Thwaites 654 in Herb. Peradeniya, but neither bears *Peniophora* setae, and consequently neither is *Peniophora setigera* (Fr.) Bres.

297.—Grandinia granulosa Fr. var. candida

Berkeley and Broome recorded this in Fungi of Ceylon, No. 560, from Thwaites 327, without description. Thwaites, in Herb. Peradeniya, placed his 326 and 327 on the same sheet. Berkeley and Broome apparently did not describe Thwaites 326. The mixture contains three species, two of which might be styled candida, while the third is subtranslucent. The first two have *Peniophora* setae ; the third has long, slender, hyaline setae, united laterally into compact columns, up to 120 μ high and 30 μ diameter. None of these is *Grandinia granulosa* Fr.

298.—Grandinia lateritia B. & Br.

This was described in Fungi of Ceylon, No. 561, as " Effusa, lateritia, farinacea, granulis distinctis ; margine, si adsit, pallidiore tomentoso. Very much the colour of *Kneiffia fulva* B. & C., a Cuban species ; but the hymenium is very different."

The specimen, Thwaites 334, in Herb. Peradeniya, is effused, red-brown, pruinose, covered with minute more or less conical projections, soft, and with a byssoid margin. It is up to 0·3 mm. thick, loose and spongy internally, very loose at the base, hyaline below, becoming red-brown above. The hyphae are pale red-brown in mass, almost hyaline individually ; at the base of the fructification they are 2-3 μ

diameter, regular ; in the upper part they are more slender, down to 1 μ diameter. All the hyphae are more or less encrusted with minute globose masses of calcium oxalate. The conical projections are up to 150 μ high, and 200 μ diameter at the base ; they are composed of rather loosely interwoven hyphae, and are covered by the hymenium except at the apex. A narrow column, denser than the intervening part of the fructification, traverses it, vertically, beneath each projection, but is not composed of vertical parallel hyphae. The basidia are clavate, 12 μ high, 6 μ diameter, with short sterigmata. The spores are pale yellow-brown, spinulose, globose, 4-5 μ diameter, or oval, up to 8×6 μ.

This species is a *Tomentella*. As it has projections on the hymenium it might be placed in *Caldesiella*, but the projections are scarcely sufficiently marked for that genus. *Tomentella lateritia* being already occupied, it may be known as *Tomentella rufobrunnea* nom. nov.

299.—Merulius versiformis B. & Br.

Berkeley and Broome described this species from Thwaites 660 as " Tenuis, primum pulverulentus graniferus ex ochraceo rufus, demum gelatinosus ; hymenio vix poriforme. At first forming a thin ochraceous pulverulent stratum, which is scattered with granules after the fashion of a *Grandinia* ; but the hymenium gradually changes colour, and becomes of a gelatinous texture, with raised irregular processes, which hardly form pores."

In Thwaites 660 in Herb. Peradeniya, there are three species, one on bark of a dicotyledon, a second on *Oncosperma* (?), and the third chiefly on fragments of wood. I have not examined the type in Herb. Kew, but it would seem probable that a similar mixture occurs in it, as Berkeley and Broome's description appears to refer to at least two of the three species.

The specimens on fragments of wood are ultimately gelatinous and furnished with distinct processes ; consequently these may be taken as *Merulius versiformis*. The fungus begins as a thin byssoid layer, on which minute, red-brown, translucent, slightly pulvinate masses develop Ultimately a continuous, red-brown, thin, gelatinous layer is formed, from which arise minute scattered processes. The gelatinous layer is up to 60 μ thick, translucent, and composed of fused hyphae more or less parallel to the substratum. The processes are similarly translucent, conical or subcylindric, projecting about 50 μ ; they arise from the base of the stroma and are composed of parallel hyphae. No basidia have been observed. The specimen is immature, and might be a *Heterochaete* or an *Odontia*. It is surely not a *Merulius*, and Berkeley and Broome's name should be discarded. The descriptions of the other

two species in Thwaites 660 are as follows, the colours being those of the herbarium specimens.

Peniophora (*Scopuloides*) *ceracea* Petch, n. sp. Effused, dull orange red in the centre, passing into ochraceous, then yellow, outwards, with a narrow, byssoid or pulverulent, white margin, waxy, slightly pruinose; up to 0·1 mm. thick, the lower half composed of loosely interwoven, irregular hyphae, enclosing numerous masses of calcium oxalate, the upper half yellow, compact, subtranslucent; cystidia hyaline, cylindric, obtuse, encrusted, 36-50 μ high (probably longer), 8-10 μ diameter, projecting up to 30 μ, fasciculate in groups up to 60 μ diameter; basidia cylindric, 12 μ long, 3 μ diameter; spores oval, spinulose, 4 × 3 μ. On bark, Central Province, Ceylon; Thwaites 660 in part.

Peniophora fracta Petch, n. sp. Effused, ochraceous (?), uneven, cracking into small areolae when dry, pruinose; up to 0·2 mm. thick, internally stratose, yellow-brown with red-brown zones below, pale yellow above; tissue loose, of stout irregular hyphae and irregular yellow-brown translucent masses of fused hyphae and cystidia; basal layer of yellow-brown hyphae parallel to the substratum; cystidia hyaline, encrusted, cylindric, obtuse, up to 80 μ high, 8 μ diameter, projecting 25 to 45 μ, scattered on the surface, but crowded in the buried zones. On *Oncosperma* (?), Central Province, Ceylon; Thwaites 660 in part.

300.—Clavaria chlorina B. & Br.

This was described in Fungi of Ceylon, No. 680, as "Simplex vel subramosa rugosa viridis, stipite tenui (No. 200). On the ground amongst leaves, Nov. 1867. Sometimes forked or proliferous. Spores ·00015 long, setulose."

The specimens are up to 5 cm. high, simple, or with a short lateral branch near the base, 1 mm. diameter below, elongated fusiform or clavate, expanding to 2 mm. diameter above, laterally compressed (? only in drying), pruinose below, waxy above, apex obtuse. In section, the clava shows a central, horny and subtranslucent core, surrounded by a loose plectenchymatous tissue, 30-60 μ broad. The hyphae are chiefly thin-walled, but both in the central core and the looser peripheral layer, there are scattered, solid hyphae, 4 μ diameter, which stain deep yellow-brown with iodine. At the exterior, the plectenchymatous tissue forms a continous layer of cells about 4 μ diameter and 6 μ deep, and from each of these there arises a cluster of elongated flask-shaped phialides, about 15 μ long, 2 μ diameter below, tapering to the apex. The phialides form a yellow palisade layer, which contrasts strongly with the hyaline looser tissue below it. The clava bears a dense layer of spores, which are pale

yellow, faintly warted, oval, 2-3 × 1·5-2 μ. Berkeley and Broome's " setulose " was probably a misprint for spinulose.

This fungus is evidently not a *Clavaria*. It is a conidial species, but not the conidial stage of a *Penicillopsis*. Its true position is doubtful.

301.—Lycoperdon fucatum Lév.

The list of Ceylon fungi sent by Gardner (Decades of Fungi, XV-XIX, Hooker's Lond. Jour. Bot., VI, pp. 479-514), Berkeley recorded *Lycoperdon fucatum* Lév., Gardner No. 16.

In the cover of *Lycoperdon fucatum* in Herb. Kew, there are two Ceylon gatherings. One marked " Ceylon, Gardner " consists of four parts of specimens ; it is immature, but appears to be *Sarcoxylon aurantiacum*. The other contains one specimen, marked "16, on old trees, Hantane, June 44" by Gardner, and "*Lycop. fucatum* Lév." by Berkeley. This latter specimen is *Lasiosphaera Fenzlii* Reichardt. The statement that it grew on trees is probably an error, as all specimens recently collected have grown on the ground. Massee, Mon. Genus Lycoperdon, (Jour. Roy. Microscopical Soc., 1887, pp. 701-727) recorded *Lycoperdon fucatum* for Ceylon, and stated that it grew " on the ground and on old trees, " the latter habitat probably having been taken from the herbarium sheet of the Ceylon specimen.

302.—Lycoperdon rugosum B. & C.

This species was recorded for Ceylon in Berkeley and Curtis, Cuban Fungi, No. 504, and the record was repeated by Massee in Mon. Genus Lycoperdon (*loc. cit.*). There is no Ceylon specimen of *Lycoperdon rugosum* in the cover in Herb. Kew.

303.—Sclerotium (Mylitta) ligulatum Ces.

Cesati, in his account of the fungi collected in Ceylon and Borneo by Beccari, described *Sclerotium ligulatum*, which was found on Pedrotalagalla, Ceylon. It was " Olivaceum, difforme, cylindraceum v. compressiusculum, pistillare vel turbinatum, passim bifidum, carnosum, intus album, contextu e vesiculoso granulari ". What is believed to be the same species was collected in a cave on Pedrotalagalla in 1904. and has been found common in certain fields on an up-country tea estate,

The sclerotia are irregularly ovoid or subglobose, usually with a more or less undulating surface, and of the same variability in size and shape as a potato. The largest specimen seen measures 6×4·5 × 4 cm. The colour is brown, or blackish-brown, externally, and the surface is rough and divided into more or less polygonal areolae, separated by shallow

furrows. Internally the sclerotium is very hard, and consists of translucent masses separated by white veins. It is evidently a *Mylitta.*

Berkeley, Currey, and Hanbury in Trans, Linn. Soc., XXIII (1860), pp. 91-96, described a similar sclerotium from India. Berkeley stated that its structure was very like that of *Mylitta australis*, and, though there was a slight difference in the outer coat, it was probably the same as the *Mylitta* of China, *Mylitta lapidescens* Horaninow. Currey and Hanbury agreed that the Chinese and Indian species were the same. Butler (Fungi and Disease in Plants, p. 13) states that *Mylitta lapidescens* occurs in the Nilgiris, where it is known as " Little man's bread. "

It is most probable that the *Mylitta* from South India is identical with that of Ceylon, though, of course, it is impossible to make any correct statement until the fructification has been found in each case. In Ceylon, the only basidiomycetous fungus known to grow from a true sclerotium is *Fomes rhinocerotis* Cooke, but that has been found only in the low-country, while *Sclerotium ligulatum* is known only from above 3000 feet, Pedrotalagalla being the highest point in the Island. But, in the absence of fructifications, the name *Mylitta ligulata* should be employed for the Ceylon species, rather than *Mylitta lapidescens*, as the type locality of the latter is China, not India, and consequently it is most probable that the two sclerotia belong to different species of fungi.

One correspondent informed me several years ago that in the Nuwara Eliya district (Pedrotalagalla) these sclerotia are cooked and eaten, but I have not been able to obtain confirmation of that. They are known by the Sinhalese name, Sita aggala, and by the Tamil name, Ravanon kolai koddai, from which it would appear that they are more widely distributed than our records show. Both these names have reference to the following well-known incident in the legendary history of Ceylon.

Sita, the wife of Rama, King of India, was abducted by Ravana and carried off to the jungles of Ceylon. There she fasted forty days, and during that period, being desirous of making certain offerings, asked for fruits, etc., to be supplied. Ravana, however, sent her cooked rice, whereupon, she, considering that an attempt to induce her to break her fast, made the rice into balls and threw it away, at the same time invoking curses on Ravana and all his family. Sita aggala means Sita's cakes, while Ravanon kolai koddai may be translated as the fatal gift of Ravana.

304.—Nectria stenospora B. & Br.

This species was discussed in Hypocreaceae Zeylanicae (Ann.Perad , VII, p. 104). It was described by Berkeley and Broome in Fungi of Ceylon, No. 1011, as " Caespitosa e matrice alba oriunda ; peritheciis minutis pellucido-coccineis collapsis ; sporis angustis uniseptatis. On

soft decaying stems. South of the Island, July 1868. Sporidia 10-12·5 μ long, 2·5-3·75 μ wide."

The specimen was part of Thwaites 647, a number which provided *Nectria stenospora*, *Nectria trichospora*, *Nectria sanguinea*, *Nectria bicolor*, *Nectria Bambusae*, and *Nectria pityrodes* var. *saccharina*.

The supposed type specimen in Herb. Kew has been examined by von Höhnel, who found that it contained five species, *viz. Nectria stenospora*, *Nectria bicolor*, *Nectria luteococcinea* (=*N. haematococca* B. & Br.) *Calonectria sulcata* (=*Calonectria rigidiuscula* B. & Br.), and *Nectria flocculenta* (=*Nectria flavolanata* B. & Br.). von Höhnel stated that *Nectria stenospora* occurred sparingly on the type specimen ; it was apparently so scanty that there are now no specimens left. von Höhnel indicated on the herbarium sheet the position of the last four species, but he did not mark *Nectria stenospora*.

The species which von Höhnel took as *Nectria stenospora*, according to his description (Mitt. XIV, p. 31) has perithecia situated in small groups on a feebly developed, erumpent stroma ; they are cinnabar-red, globose, not collapsing, smooth, 250-280 μ diameter, with a small, flat, ostiolar papilla. The asci are clavate, with biseriate spores, 50-60 ×9-10 μ. The spores are straight, elongated-elliptic, with obtuse ends, not constricted at the septum, hyaline, with four or five longitudinal striae, 10-14 × 4-5 μ.

As previously pointed out (*loc. cit.*) von Höhnel's description differs from Berkeley and Broome's in several details. The latter state that perithecia arise from a white stroma, are pellucid red, and collapse ; von Höhnel does not refer to a white stroma, does not describe the perithecia as translucent, and states that they do not collapse. Because of these discrepancies, it was suggested, in dealing with this species in Hypocreaceae Zeylanicae, that the name should be applied, not to von Höhnel's species, but to another which formed part of Thwaites 647 and is otherwise unrecorded.

However, on consulting the Herbarium of the British Museum (Natural History), it was found that that Herbarium possessed an ample specimen of *Nectria stenospora*, *ex* Herb. Broome, which answers completely to the macroscopic characters of the original description. Under this name in Herb. B. M. are two sheets *ex* Herb. Broome. One of them is Ceylon 647 ; the fungus is on dead herbaceous stems, and it appears to be all the same species ; it is accompanied by a drawing, and a spore measurement "0. 0004-0·0005 l., 0·0001—0·00021 w." This is undoubtedly *Nectria stenospora* B. & Br. The other specimen is marked 647 bis ; it is a mixture, and contains the species which I suggested in Ann. Perad., VII, p. 106 was *Nectria stenospora*.

In Thwaites 647, *Nectria stenospora*, in Herb. B. M., the perithecia are in small groups, either without a visible stroma, or situated round a yellowish white tuft of hyphae. The perithecia collapse centrally; they are either pale ochraceous and almost opaque, or dark brownish red and subtranslucent, both colours occurring in the same group The perithecia are globose, with a minute, conical ostiolum, 0·2-0·25 mm. diameter, at first pruinose, becoming almost glabrous, rugose; when mounted, the perithecial wall is pale yellow. The asci are clavate, eight-spored, with spores biseriate above and uniseriate below, 50 × 8 μ. The spores are narrow-oval, ends obtuse, not, or slightly, constricted, one-septate, hyaline, minutely verrucose, 10-14 × 4-5 μ.

There is not much doubt that this is the real *Nectria stenospora* of Berkeley and Broome. But it is also quite evidently *Nectria bicolor* B. & Br. von Höhnel did not describe *Nectria bicolor*, but stated that it was scarcely different from *Nectria ochroleuca*. Berkeley and Broome's description of *Nectria bicolor* does not differ much from that of *Nectria stenospora*, and it would appear that they gave the former name to specimens which lacked the white matrix. The spores of *Nectria bicolor* were given as 8·75 μ long and 2·5 μ broad.

Nectria bicolor B. & Br. is consequently a synonym of *Nectria stenospora* B. & Br.

In one recent gathering of *Nectria stenospora*, the ascospores are 8-10 × 3 μ, rarely 4 μ broad. The conidial stromata are pulvinate, rather loosely-built, pink, sometimes with a white byssoid margin; the conidiophores are short and branched, and the conidia are narrow oval, 4-11 × 1·5-3 μ.

The remaining *Nectria* of Thwaites 647, which occurs in Herb. Kew in the cover of *Nectria bicolor* and in the cover of *Nectria sanguinea*, is apparently undescribed. It may be known as *Nectria flavistroma*.

Nectria flavistroma n. sp. Perithecia densely crowded on an erumpent stroma in pulvinate masses up to 5 mm. diameter. Stroma parenchymatous, composed of small thick-walled cells, or somewhat sclerotioid, orange-red above, yellow internally, paler towards the base. Perithecia bright red, becoming dark red, subtranslucent, glabrous, ovoid or suburceolate, 0·15-0·25 mm. diameter; ostiolum broadly conical, darker than the perithecial wall, ochraceous at the apex; perithecial wall, in section, yellow internally, red towards the exterior, composed of thick-walled cells 8 μ diameter, the outer layer somewhat amorphous. Asci sessile, narrow-clavate, 50-65 × 6-9 μ, eight-spored, spores obliquely uniseriate. Paraphyses linear. Spores hyaline, oval, obtuse, not constricted, one-septate, 10-13 × 4-7 μ.

Parasitic on Sphaeriaceae, Ceylon: Thwaites 647 in part.

305.—Nectria villigera B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 1012 (Jour. Linn. Soc., XIV, p. 115) as " Conglomerata : peritheciis ovatis rugosis pallidis : floccis conidiiferis conidiis longiseptatis magnis ellipticis vel obovatis (No. 156). Apparently on some decaying fungus. Nov. 1867. Surface of perithecia rough. "

I was unable to find the type specimen of *Nectria villigera* in Herb. Kew, or Herb. British Museum in 1915, and consequently this species could not be redescribed in " Hypocreaceae Zeylanicae ", Ann. Perad., VII, pp. 85-138. In 1920, during an examination of the Kew specimens of *Nectria* for scale insect parasites, the type of *Nectria villigera* was discovered.

The specimen answers to Berkeley and Broome's description. It consists of subglobose or ellipsoid bodies, heaped together in loosely caespitose masses. The individual " perithecia " are rough, subtranslucent or opaque, pale yellow, dark amber, dark orange, or dark red brown, 0·2-0·25 mm. diameter. They are bound together by scanty hyaline mycelium, and sometimes bear scattered, erect, hyaline hyphae.

Examination shows that these are masses of insect frass, bound together by mycelium. The mycelium is probably that of a *Fusarium*. I was able to obtain only small, non-septate, hyaline conidia.

The name *Nectria villigera* is consequently to be discarded.

306.—Sphaerostilbe lateritia B. & C.

This species was recorded for Ceylon by Berkeley, in Fungi Cubenses, Jour. Linn. Soc , X (1869), p. 377. There is no Ceylon specimen in the herbaria of the British Museum and Kew, but in the latter there is a specimen collected by Gardner in Brazil in 1841, which may be the one Berkeley had in mind, as Gardner subsequently came to Ceylon and the name of the locality on the specimen, Maranham, resembles a Ceylon name.

307.—Hypocrea multiformis B. & Br.

For this species, Berkeley and Broome cited the Thwaites' numbers, 1094, 1095, 1096, 33 in part, in Fungi of Ceylon, No. 995. 1096 is 33 in part, while 1094 and 1095 are parts of Thwaites 5. This species was discussed in Ann. Perad., VII, p. 96, where it was pointed out Berkeley and Broome cited 5 in part, 1094, for *Hypocrea citrina* var., and 5 in part for *Hypocrea albofulva* B. & Br., *Hypocrea discella* B. & Br., and *Hypocrea catoptron* B. & Br., and that the herbarium specimens were mixtures. In conclusion, it was stated " It may be that there is another

species in Thwaites 1094 in Herb. Kew or Herb. British Museum, to which the name *Hypocrea multiformis* might be applied, but in view of the mixture cited by Berkeley and Broome it would seem preferable to discard the name."

Since then the specimens in Herb. Kew and Herb. British Museum have been re-examined. Confining attention to Thwaites 1094, it has been found that in both herbaria there are two sets of specimens under that number. In Herb. Kew, each set of specimens contains two species, part being marked *Hypocrea multiformis* and part *Hypocrea citrina* var. In Herb. British Museum, there is apparently only one species in the two specimens marked *Hypocrea multiformis*. The *Hypocrea multiformis* of these specimens proves to be distinct from those previously examined, and if the name be restricted to Thwaites 1094 in Herb. B. M., and the part of 1094 so labelled in Herb. Kew, it will stand as a valid species. It is near *Hypocrea citrina* var. (=*Hypocrea straminea*) in some respects, but apparently sufficiently distinct. It has not been matched by any recent gathering.

Berkeley and Broome's description probably refers to more than one species. The specimens are not "umbrinella," and the perithecia are not prominent.

The stromata are discoid, up to 1·5 mm. diameter and 0·6 mm. thick, with a rounded margin, attached over a central area the diameter of which is about one third that of the base, but not contracted below. The surface is slightly irregularly wrinkled and tuberculate, and the margin incised. The stromata are ochraceous, with dark brown ostiola, which are punctiform and almost black when the perithecia are immature; they appear opaque, but the internal tissue is subtranslucent in section. The perithecia are crowded in a single peripheral layer, the tissue between the bases of the perithecia being yellow; they are globose, 0·15-0·2 mm. diameter, or laterally oval, 0·25 × 0·15 mm., with a yellow wall. The asci are about 60 μ long and 3 μ diameter. The part-spores are not quite mature; they are greenish hyaline, almost smooth, globose, 3 μ diameter, or cuboid, 4 × 3 μ.

308.—**Botryosphaeria catervaria** (B. & C.) Sacc.

In Saccardo, Sylloge, I, p. 462, there is listed "*Botryosphaeria catervaria* (B. & C.) Sacc., *Diatrype catervaria* B. & C. in N. Pac. expl., p. 128, n. 156,—Stromatibus parvis in maculis aggregatis, papilla centrali notatis, quandoque confluentibus; ascis brevibus; sporidiis globosis. Hab. in foliis *Fici*, Hongkong, Ceylon."

In Annales Mycologici, XIV, p. 329, Theissen remarked that "Stromata die mit einer gemeinsam Zentralpapille versehen sind, konnen

nicht einer *Botryosphaeria* angehoren ; auch kugelige Sporen sind der Gattung fremd. "

Diatrype catervaria was not included by Berkeley and Broome in the Fungi of Ceylon. As far as the Ceylon reference is concerned, this is probably the specimen on *Ficus oppositifolia* (*Ficus hispida* L. f.), collected by Thwaites, Oct. 12, 1850, and recorded by Berkeley in Hooker's Journal of Botany, 1854, p. 231, as *Dothidea repens* (Corda) var. *catervaria*. It now stands as *Phyllachora catervaria* (Berk.) Sacc.

309.—**Botryosphaeria inflata** Cke. & Massee.

This species was re-described in Ann. Perad., VII, p. 26. Cooke and Massee found, on the type specimen, *Nectriella gigaspora* Cke. & Mass. The latter was re-described in Ann. Perad., VII, p. 122, as *Pseudonectria gigaspora*. von Höhnel, in discussing *Botryosphaeria xanthocephala* (Syd. & Butl.) Theiss., which has a black stroma with yellow beaks, suggested that *Botryosphaeria inflata* is identical with the latter, Cooke and Massee having mistaken the yellow beaks for *Nectriella* perithecia (Fragmente zur Mykologie, XXIV, p. 7). *Botryosphaeria inflata*, however, does not possess yellow beaks, and *Nectriella gigaspora* is a distinct species, which is parasitic on Sphaeriaceae, etc.

310.—**Micropeltella Thwaitesii** Petch.

In Annals Peradeniya, VII, page 34, it was shown that the specimen from Ceylon, listed by Berkeley and Broome as *Micropeltis applanata* Mont., was not that species. It had two-septate spores, and had no paraphyses. The name *Micropeltella Thwaitesii* was adopted for it, with the suggestion that Sydow's genus *Micropeltella*, as limited by Theissen, should be enlarged to include species with spores two-septate.

Specimens of this fungus have recently been collected on *Aporosa lanceolata* Thw., and with the help of these the former description can be extended. The perithecia occur on the upper side of the leaf ; they are scattered, black, scutate, circular, slightly radially rugose, about 0·5 mm. diameter, with the centre elevated and somewhat columnar. The cover is netted, not radial, opaque in the centre, becoming hyaline at the margin ; in Berkeley and Broome's specimens there is a distinct blue-green tinge at the edge of the cover, but this is not evident in the more mature recent examples. There is no trace in the latter of the layer of crystals noted in the former. The asci are clavate, sessile, eight-spored, 55 × 12 μ. The spores are greenish hyaline, fusoid, straight or curved, five-septate, constricted at the septa, ends rounded, the upper cell usually the larger, 20-25 × 6 μ. On re-examination, similar spores have been found in Berkeley and Broome's specimen.

There is consequently no need to extend the genus *Micropeltella* in order to include this species.

311.—Phoma pelliculosum B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 801, as "Griseum, e matrice secernibile; peritheciis minutissimis epidermidem elevantibus ostiolo amplo; sporis angustis, quam sporophoribus triplo brevioribus (No. 438). On bamboo, Peradeniya, December 1867. Peeling off in little ragged shreds: spores ·0001 long."

The bamboo bears a very thin, grey or greenish film, in which the pycnidia are embedded. The latter are scattered, black, up to 0·15 mm. diameter, flattened-convex, ostiolate, at first covered by the film, and ultimately breaking through it. The base of the pycnidium is flat and hyaline, and rests on the bamboo. The upper wall is black, opaque, fragile, with a fimbriate lower edge which shows a radial hyphal structure at the extreme margin: it forms a shield-like cover to the pycnidium. The ostiolum becomes widely open, the cover breaking away so that only a ring remains. A few fuscous hyphae, 2-4 μ diameter, run over or in the film.

The grey film can be peeled off the substratum, and it brings away with it the whole of the pycnidia, no evident trace of them being left on the bamboo. In the type specimen, the broken pycnidia then appear as rings up to 50 μ broad, with a hyaline inner ring of spores and basidia, surrounding a central hole.

The spores are minute, hyaline, oblong-oval, 3-5 × 1-1·5 μ, with many globose, 1 μ diameter. The basidia are short and simple, about 6 μ long, with a few long paraphyses, up to 50 μ long.

In Kew Bulletin, 1921, p. 150, Grove transferred this species to *Eriothyrium* Speg., at the same time amending the generic description of the latter. *Eriothyrium*, as amended by Grove, includes species which have scutato-dimidiate pycnidia, which are adnate, ostiolate, surrounded by an effused, very thin, smoky or fuscous-pallid subiculum, and have hyaline, continous spores.

Grove's description states that the pycnidia are black, 50-100 μ diameter, crowded, round, shield-shaped, dimidiate, applanato-convex, pierced by a wide, central, round or irregularly impressed pore; texture of dark-brown cells, about 2-3 μ diameter, distinctly radiating especially at the margin; spores narrow-oblong, straight or curvulous, about 3 × 1 μ; sporophores rod-shaped, up to three times as long, springing from the underside of the shield.

Grove describes the fungus as occurring under the cuticle of bamboo stems. "The mycelium appears to arise in the epidermal cells, which

it ultimately destroys, leaving a layer of hyphae lying on the sclerenchymatous zone which underlies the epidermis and separating easily therefrom." "The pycnidia are immersed in, and at first covered by, a thin membranous subiculum, which appears to be composed of densely interwoven, pallid hyphae, adherent to the cuticle; at length the vertex of each shield emerges from the weft, splitting the cuticle and opening by a pore which gradually grows wider; ultimately the shield falls away entirely, leaving a little pit. The cells of the subiculum are thin-walled, very indistinct and tightly packed, forming a pseudoparenchyma, but occasionally the course of the separate radiating hyphae can be discerned."

In the specimens in Herb. Peradeniya, no radial structure is evident in the shield except at the margin. Otherwise Grove's re-description agrees with Ceylon observations, with the following exception. The film in which the pycnidia are embedded is quite superficial. It is composed of irregular hyphae, 1-2 μ diameter, thick-walled or almost solid, with a narrow interrupted lumen. These hyphae form a network in the thinner parts, but become more interwoven and denser in the older parts, and are intermingled with alga cells. When fresh the film is green at first, becoming greyish green later. It is particularly conspicuous on the stems of the yellow bamboo, the natural surface of which is glabrous.

There does not appear to be any doubt that the superficial film is a lichen thallus, and that the fungus is parasitic on the lichen, not on the bamboo. As the film is not the mycelium of the fungus, the latter cannot be assigned to *Eriothyrium*. It would appear to be *Actinothecium*, and may stand as *Actinothecium pelliculosum*.

312.—**Phoma coryphae** Cooke & Massee.

The description of this species was published in Grevillea, XIX, p. 75, in an unsigned article entitled "Omitted Diagnoses", which professed to contain descriptions which had been omitted from Saccardo's Sylloge. Some of these descriptions, however, including the one under notice, had never been previously published, and consequently no blame could attach to Saccardo for the alleged omission.

Phoma coryphae was described as "Peritheciis laxe gregariis erumpentibus, conicis, basi insculptis, atris, papillatis (0·5-0·3 mm). Sporulis arcte ellipticis, utrinque rotundatis, hyalinis, 12 × 3 μ. On palm petioles. Ceylon, 649."

The type specimen in Herb. Kew bears a label with the inscription by Thwaites "No. 649, S. of the Island, July 1868." Thwaites 649 was *Sphaeria agnocystis*, and the type of the latter bears another Thwaites's label with the same inscription, and in addition the words "compare

with 268." There is also, under *Sphaeria agnocystis*, another piece labelled "Ceylon, 649," *ex* Herb. Currey (?), which is the same as *Phoma coryphae*.

Cooke and Massee wrote the specific name without a capital. It is doubtful, therefore, whether they believed the host plant to be *Corypha*. If they did, it is not clear whence they derived that information. The host is a bamboo.

The surface of the host plant is covered by a thin greenish-grey layer with a black margin running transversely across the stem. This is a lichen. Over the surface of the lichen run widely-separated, dark-brown hyphae, 2-4 μ diameter. The pycnidia are seated on the exterior of the bamboo, and break through the lichen covering. They are up to 0·3 mm. diameter, and 0·3 mm. high, black, conical, with an even or papillate ostiolum. The wall is brittle, carbonaceous and opaque except at the extreme margin. The base is flat, black, except in the centre, where there is a subtranslucent circular area about 12 μ diameter. On peeling off the lichen, the pycnidia are detached with it, except for a narrow, irregular, interrupted ring derived from the margin of the pycnidium. This ring consists of irregularly fused, more or less radial, dark brown hyphae, 2-3 μ diameter. The base of the pycnidium is not immersed in the tissues of the bamboo

The spores are hyaline, cylindric or oblong oval, 3-5 × 1·5-2 μ. They are borne on short, simple basidia, up to 8 μ long, with which are intermingled a few long hyaline paraphyses, up to 50 μ long, 1 μ diameter. The pycnidium contains quantities of calcium oxalate in large irregular masses, up to 32 × 20 μ.

This species is similar in structure to *Phoma pelliculosum*. Like the latter, it is parasitic on a lichen, and it has exactly the same spores and paraphyses. It differs from *Phoma pelliculosum* in its larger pycnidia, and in leaving a ring, the margin of the pycnidium, attached to the host plant when the lichen film is peeled off. The latter may be a consequence of the greater development of the pycnidia. The differences do not appear to warrant the separation of *Phoma coryphae* from *Phoma pelliculosum*.

313.—Phoma Lobeliae B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 802, as "Pustulis epidermide alba tectis, demum emersis; sporis ellipticis (No. 301). On *Lobelia nicotianaefolia*, Nuwara Eliya. Spores ·00015 long."

No fungus answering to this description could be found in the co-type in Herb. Peradeniya, and consequently in a previous communication it was suggested that the species was a *Phomopsis* which occurs

on the same host at Nuwara Eliya. An examination of the type in Herb. Kew has, however, shown that that is incorrect.

Lobelia nicotianaefolia has flowering stems up to about four feet in height and an inch and a half in diameter. These are a prominent feature in the landscape at Nuwara Eliya, both during and after flowering. The stems are woody, and they take several months to decay. Consequently the erect dead stems persist for a long time. The type specimen of *Phoma Lobeliae* is on a piece of a decaying stem ; it consists of part of the woody cylinder, covered chiefly by the persistent membranous epidermis. Berkeley and Broome's "epidermide alba" refers to the spots where nothing but the bleached epidermis overlies the wood.

The pycnidia are superficial on the wood, either scattered or in small groups, with the ostiola just penetrating the epidermis. When the dead epidermis is removed, the pycnidia can be lifted off the wood with a needle. They are about 0·3 mm. diameter, globose or flattened globose, with a small conical ostiolum, black, not carbonaceous. When mounted, the wall is membranous, dark brown, black round the ostiolum, the outer layer somewhat amorphous and bearing a few adherent dark-brown hyphae, 3 μ diameter. The spores are brown in mass, yellow-brown to almost hyaline when viewed separately, smooth, oval, 3·5-5 ×2-2·5 μ or globose, 3 μ diameter.

This is apparently *Coniothyrium*, and will stand as *Coniothyrium Lobeliae* (B. & Br.). But it would appear probable that the fungus is merely saprophytic, and is not peculiar to *Lobelia*.

314.—**Phoma hysterioideum** B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 803, as "Ellipticum, nigrum, epidermide cinctum, opacum ; sporis oblongis minimis (No. 509). Possibly a state of *Dothidea graminis.*" In Herb. Peradeniya, Thwaites 509 and 733, on *Panicum fluitans* are included under *Dothidea graminis.* Berkeley and Broome cited Thwaites 733 for the latter species, but not Thwaites 509. There is no specimen under the name *Phoma hysterioideum* in Herb. Kew, but Herb. British Museum has a specimen *ex* Herb. Broome, labelled by Thwaites "509, *Phoma* on *Panicum fluitans*," with a drawing by Broome which shows an ascus and spores.

The stromata appear as black, slightly elevated, oval spots, up to 0·6 mm. long and 0·35 mm. broad, scattered over the upper surface of the leaf : they are not evident from the lower surface. The stroma is about 0·2 mm. thick, covered by the cuticle, or the outer wall of the epidermal cells of the host, and extending in the mesophyll down to the

vascular bundles. The wall is black and dothideoid at the sides and over the top, with a thin, brownish basal layer. The sides expand towards the base, and may attain a thickness of 50 μ there. Only one loculus, laterally oval, is seen in transverse section, as a rule. In some cases, however, two loculi appear, but these are separated by a black wall, and most probably are cross sections of two confluent stromata. The loculi contain asci, which are clavate, 80 × 16 μ, or broadly clavate, 64 × 20 μ. The spores are hyaline, ellipsoidal, continuous, 10-14 × 6-8 μ. Numerous linear paraphyses are present.

In all the stromata examined, the loculi contain minute, hyaline, oval spores, 2-3 × 0·5-0·75μ, or less. These are situated above the mass of asci and paraphyses, and are probably derived from the latter. No case was observed in which the loculi contained these spores only; even when they were most numerous, well-developed paraphyses and immature asci were present.

Phoma hysterioideum, consequently, is a pycnidial stage of *Phyllachora graminis* (*sensu lato*), as suggested by Berkeley and Broome. But it is not, from the specimens examined, a true *Phoma*, nor a distinct form of the *Phyllachora*. It is merely a transitory stage in the development of the ascigerous loculus.

315.—Hendersonia Symploci B. & Br.

Berkeley and Broome's description of this species in Fungi of Ceylon. No. 794, is " Peritheciis nitidis, saepe circinantibus ; sporis fusiformibus triseptatis (No. 592). On *Symplocos obtusa* Wall. Central Province, 5000 ft. Spores ·00012 long. No. 455 is a doubtful species of the same genus. " In Herb. Peradeniya, Thwaites 592 is labelled Nuwara Eliya, and 455, Central Province.

There are two species in Thwaites 592, on leaves of *Symplocos obtusa*. One, the more numerous, has minute shining stromata, often arranged in circles, with no evident discoloration of the leaf. The other has rugose, dull black pycnidia on circular discoloured spots.

The latter fungus causes circular spots, purple-brown or black-brown, often concentrically zoned, slightly raised, about 1 mm. in diameter. In the middle of these spots there arises a single pycnidium, flattened globose, rugose, black, 0·5 mm. diameter, or a group of two or three globose pycnidia, about 0·25 mm. diameter. The pycnidia break through the surface of the spot, and become almost superficial, surrounded by the ruptured epidermis. Ostiola are not evident. The upper part of the wall of the pycnidium is thick and almost carbonaceous, and in sections it splits away in manner suggestive of the Leptostromataceae, but that does not appear to occur naturally. The spores are rather pale

brown, fusoid or cylindric, ends obtuse, three-septate, not constricted, collapsing, 22-32 × 4-6 μ. The basidia are short.

The second species is common at Hakgala on *Symplocos* spp., and has been collected on *Symplocos elegans*, *S. obtusa*, and *Symplocos latiflora*. The stroma are minute, up to 0·25 mm. diameter, subcuticular, broadly conical, with a flat base overlying the epidermal cells. They occur on either side of the leaf, frequently arranged in circles, and are black and shining, not erumpent, The upper layer, or cover, is black, opaque, up to 50 μ thick ; the basal layer is black and thin, 4-16 μ thick. The thin edge of the stroma is usually opaque, but it may extend laterally for some distance, underlying the cuticle and appearing from above as a sheet of laterally-united, radial hyphae. The thickness of the stroma in the centre is about 0·1 mm. Each stroma contains a single, laterally oval loculus, the space between the loculus and the margin of the stroma being filled with more or less vertically parallel, brown hyphae. The asci are thick-walled, clavate or subcylindric, 90 × 16 μ, eight-spored, spores biseriate. They are embedded in a tissue of thin, parallel, adherent, hyaline hyphae. The spores are brown, fusoid or oblong-oval, with obtuse ends, three-septate, sometimes scarcely constricted, sometimes so strongly constricted at the median septum that they readily separate into two, 15–20 × 4–5 μ. The asci are soon diffluent, and in very many cases only the spores are found in the loculus.

Berkeley and Broome's description evidently includes both species. The spores described are, from their size, those of the pycnidial fungus, while the phrases, " Peritheciis nitidis, saepe circinantibus " refer to the ascigerous species.

Pending the full revision of the Sphaeropsidales, the first species may be left under Berkeley and Broome's name, *Hendersonia Symploci*. The second is a *Dermatodothis*, which has been named *Dermatodothis zeylanica* Syd.

Thwaites 455 is *Dermatodothis zeylanica*.

316.—Hendersonia constricta B. & Br.

Berkeley and Broome's description of this species in Fungi of Ceylon, No. 795, is " Peritheciis subglobosis pruinatis, basi floccis radiantibus suffultis; sporis metulaeformibus uniseptatis, medio constrictis (No. 351). On dead wood. Spores ·0009 long. " Saccardo, in listing it in Sylloge, III, p. 442, added " An Diplodiella ? an Staganospora ?". There is apparently no specimen in Herb. Kew. The type is in Herb. British Museum.

The wood is covered with a dense weft of dark brown, fairly regular, septate hyphae, forming a somewhat compact layer about 0·5 mm.

thick. The perithecia are embedded in this layer and are not visible to the naked eye. They are globose, 0·2 mm. diameter, or vertically oval, 0·3 mm. high, 0·2 mm. broad. The hyphae in which they are embedded arise both from the substratum and from the wall of the perithecium. The latter is thin and fragile, and consists of an outer brown layer of large cells,up to 16 μ broad, and an inner hyaline layer. The spores are pale fuliginous,narrow-oval or oblong-oval, ends rounded, one-septate, constricted at the septum, 16-26 × 6-8 μ. Most of them lie loose in the perithecium, but they are undoubtedly ascospores, and remains of the asci with included spores are present.

This species is *Neopeckia*, and will stand as *Neopeckia constricta* (B. & Br.).

317.—Sphaeropsis annularis B. & Br.

Myrosporium rufum B. & Br.

In Fungi of Ceylon, No. 792, Berkeley and Broome described *Sphaeropsis annularis* B. & Br., " Lateritia, peritheciis centro depressis ; sporis subcunciformibus (No. 114). On dead wood, Nov. 1867. Looks like a collapsed *Nectria* ; spores ·0005 long." In Saccardo, III, p. 615. it was listed as *Zythia annularis* (B. & Br.).

In Fungi of Ceylon, No. 793, *Myrosporium rufum* was described It was " Placentaeforme, rufum, nitidum, collabens ; sporis subellipticis (No. 1016). On petioles apparently of some palm. Peradeniya, Dec. 1868. Looks at first sight like a collapsed *Hypocrea*. About half a line broad ; spores rather variable in form, elliptic, obovate, or subcymbiform, ·0005–·0006 long, ·0004 wide. It seems to come nearer to Corda's genus than any other. Had the perithecium been black, it might rather have been referred to *Coccularia* Cd." In recording this species in Sylloge Fungorum, III, 619, Saccardo stated " Sec. Berk. ad Myrosporium Corda propius accedit, quod vero genus est Myxomyces, teste Frieso," and, from the description, he placed it in *Aschersonia*, as *Aschersonia rufa* (B. & Br.).

In Herb. Peradeniya, Thwaites placed his Nos. 114 and 1016 on the same sheet, evidently regarding them as the same species, as they undoubtedly are.

The stromata are very variable in appearance. The smallest are about 0·4 mm. diameter, evenly pulvinate, dark red brown to almost black. Others are dark red brown, or purple black, placentiform, tuberculate at the margin and depressed in the centre, 1·5 mm. diameter and 0·3 mm. thick : while the largest are irregularly tuberculate, up to 4 mm. in diameter and 1·5 mm. high, with the same variation in colour. They look like groups of collapsed Nectrias, or like a small Tremellaceous fun-

gus, being rather hard, glabrous, slightly subtranslucent, and appearing as if subgelatinous when fresh. In spite of the variation in colour macroscopically, they all present the same appearance in sections by transmitted light. The interior is pale yellow, becoming red brown towards the exterior, with a deep red brown, or blackish brown, outer layer.

At the base of the stroma is a layer of hyaline hyphae, 3 μ diameter, forming a thin, rather loose, plectenchymatous tissue. Above this the fungus appear to consist entirely of oval or globose spores, pale yellow, thick-walled, minutely verrucose, 9–16 × 8–10 μ. On staining and examination with a high magnification, slender hyphae, about 1·5 μ diameter, are found between the spores. The spores appear to be borne laterally on the hyphae. The outer red brown layer consists of agglutinated spores and fine hyphae.

The fungus is apparently a Hyphomycete, belonging to the *Tuberculariaceae*. There appear to be several genera in which it might be placed, but most of them are insufficiently known. It would seem that it might be included in *Illosporium*, judging from the descriptions of species which have been placed in that genus. It will then stand as *Illosporium annulare* (B. & Br.).

318.—Sphaeropsis Diospyri B. & Br

This was described by Berkeley and Broome in Fungi of Ceylon, No. 790, as "Nitida, congesta, incarcerata, epidermidem elevans; sporis magnis; paraphysibus longis (No. 1131). On fruit of *Diospyros embryopteris*. Peradeniya, Dec. 1868. Spores ·001 long."

Part of Thwaites 1131 is in Herb. Peradeniya. "Nitida" can only refer to the epidermis of the *Diospyros* fruit. The epidermis is raised in numerous, rather close-set, pulvinate elevations, either circular, 0·7 mm. diameter, or oval, 1 × 0·7 mm., and ultimately splits, usually longitudinally, over them. Beneath each elevation is a black stroma containing numerous pycnidia. The pycnidia are rather loosely bound together, and separate in free-hand sections. They are up to 0·3 mm. diameter, with separate ostiola, up to 40 μ diameter. The majority of the spores are immature, but dark brown, oval, one-septate spores, 26 × 14 μ. have been found. Long paraphyses are present.

The fungus is *Botryodiplodia*, and will stand as *Botryodiplodia Diospyri* (B. & Br.). Morphologically it is identical with *Botryodiplodia Theobromae* Pat.

319.—Sphaeropsis anomala B. & Br.

The description of this species, in Fungi of Ceylon, No. 788, is "Maculis minutis aterrimis rugosis, perithecüis confusis; sporis obvatis e stipite

brevi articulo divisis, demum uniseptatis (No. 481). On *Artocarpus Lakoocha* var., Peradeniya, Jan. 1868. Spores ·0013 long." In Saccardo, III, p. 300, the spores are given as 30–32 μ and the habitat " In ramis *Artocarpi Lakoochae* ;" and it is suggested that the fungus may be a *Diplodia*.

The specimen, Thwaites 481, in Herb. Peradeniya is a leaf of *Artocarpus Lakoocha*, not a stem. The fungus occurs on the upper surface of the leaf in the form of minute, black, superficial pycnidia. These pycnidia are circular or oval in plan, up to 0·5 mm. diameter, sometimes confluent, conical with a flattened margin. The surface is rugose and the margin radially sulcate. Ostiola have not been observed, but in the majority of cases the apex of the pycnidium appears to have been damaged. By transmitted light,the wall of the pycnidium is opaque, except at the margin, which is dark brown, composed of parallel radial hyphae. The pycnidium is multilocular. There is no external mycelium, but the pycnidium arises from a hypostroma, about 20 μ thick and up to 200 μ diameter, embedded in the epidermis of the leaf. The spores are pyriform or turbinate, usually truncate at the base, or ovoid, truncate above and below, black-brown, ultimately opaque ; they are borne on hyaline, cylindric pedicels, 16–26 × 4–5 μ, inflated below, which are often persistent. The spores have a single transverse septum at about one quarter the length of the spore from the base, and the upper loculus is usually strongly guttulate ; they measure 24–32 × 12–17 μ.

This species is a pycnidial form belonging to the Dothideales. It appears to agree well with *Peltistromella*, and will stand as *Peltistromella anomala* (B. & Br.).

320.—Sphaeropsis seminicola B. & Br.

Berkeley and Broome's description of this species, in Fungi of Ceylon, No. 791, is " Minuta, gregaria, libera, setis rigidis sparsa ; sporis oblongis obtusis (No. 1132). On seeds of *Artocarpus integrifolia*. Peradeniya, Dec. 1868. Spores ·0005 long." In Saccardo, III, p. 220, it was listed as *Pyrenochaeta seminicola* (B. & Br.) Sacc.

The specimen, Thwaites 1132, in Herb. Peradeniya, bears minute, irregularly circular, black spots, up to 0·2 mm. diameter, sometimes confluent. These prove to be subepidermal acervuli, which subsequently rupture the overlying epidermis, but do not open widely, as far as this specimen shows. The conidia are hyaline, cylindric with rounded ends, 12–18 × 3–4 μ. Some acervuli do not bear any setae, and are *Gloeosporium*. Others have numerous setae, and are *Colletotrichum*. In this specimen, however, the setae have been broken or bitten off, and only the bases are left in the acervuli, with fragments scattered over the host

tissue. They are dark brown, up to 7 μ diameter below, slightly expanded at the base, and have acute tips. Complete setae have not been observed.

There are also present on the specimen some loose spores of a *Melanconium*, brown, oval, lenticular, with a pale edge, 8 × 4 μ.

Berkeley and Broome's fungus is a *Colletotrichum*, which will stand as *Colletotrichum seminicolum* (B. & Br.).

321.—Diplodia Cathartocarpi B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 787, as " Peritheciis congestis e macula pallida oriundis minutissimis epidermidem elevantibus, ostiolo latiusculo; sporis oblongis utrinque subalternatis (No. 525). On either surface of leaves of *Cassia fistula*, Damboul, Feb. 1868. Spores ·0005–·001 long by ·0002 Besides there are minute conidia ·00015–·0002." In Saccardo, III. p. 337, " subalternatis " was altered to " subattenuatis."

The specimen, Thwaites 525 in Herb. Peradeniya, is marked by Thwaites " on *Cassia Fistula*, Damboul." The leaves bear minute black spots, up to 0·25 mm. diameter, crowded together, on both sides of the leaf but chiefly on the lower. These black spots are parenchymatous sub-epidermal stromata. The epidermis ruptures in several places over each stroma, and a dense cluster of dark-brown, septate conidiophores, each about 20 μ high and 3·5 μ diameter, emerges. The initial perforation of the epidermis is usually circular, and these holes constitute the wide ostiola of the description. Conidia have not been observed *in situ* on the tufts, but large numbers of detached spores lie on the surface of the leaf. The spores are subcylindric, fusoid, or narrow-oval, pale fuscous, one-septate, often constricted, slightly attenuated or rounded at the ends, 16–19 × 4–5 μ. It is probable that these spores belong to the conidiophores, but the problem is complicated by the presence of an ascomycete, with thick-walled asci, 60–72 × 12–14, the immature spores of which (in the ascus) are narrow-oval or subfusoid, hyaline, one-septate, 14–17 × 3–4 μ. There are also, as noted by Berkeley and Broome, hyaline, oval or subglobose spores, 6–7 × 4–5 μ, apparently of a *Phoma*.

The principal fungus on the specimen is a *Fusicladium*. The leaf is not *Cassia Fistula*, but quite evidently *Pongamia glabra*. And the fungus is *Fusicladium Pongamiae* Syd. The name *Diplodia Cathartocarpi* may consequently be discarded.

322.—Diplodia circinans B. & Br.

In Fungi of Ceylon, No. 786, Berkeley and Broome described *Diplodia circinans*, as " Peritheciis circinantibus epidermide nigrifacta centro

pallido tectis ; sporis brevibus ellipticis obtusissimis (Nos. 356, 357). On *Yucca gloriosa*. Perithecia two to three under each spot ; spores ·001 inch long, ·0005 wide." They added "No. 358 is a variety with the pustules more scattered, but without fruit." In Saccardo, III, p. 371, the fungus is said to grow on *Yucca gloriosa* in Ceylon and *Yucca aloifolia* in North America. The latter record is from Berkeley's Notices of North American Fungi, Grevillea, III, p. 3, "*Diplodia circinans* B. & Br. var. *diffusa*. On *Yucca aloifolia*. No. 660. Also in Ceylon."

In Herb. Kew, Thwaites 356 is marked *Diplodia circinans* ; Thwaites 357, *Diplodia circinans* var.; and Thwaites 358, *Diplodia circinans* var. *diffusa*. They are all from the same locality, Nuwara Eliya.

In Thwaites 356, the leaf bears minute, oval, black rings, up to 0·4 × 0·3 mm., with a white centre, often confluent in twos or threes. The black ring is up to 0·1 mm. broad. These rings are arranged in concentric ovals, up to 2 × 1 cm., with others irregularly scattered. In section it is found that under each minute ring there is situated a flattened parenchymatous stroma, brown at the sides but hyaline in the interior. The brown coloration does not extend over the upper surface, and hence the stroma causes a black ring with a white centre on the overlying epidermis. The stromata in No. 356 appear to be solid and sterile.

In Thwaites 357, the minute ring spots are scattered, not circinating. They are larger, up to 1·5 mm. diameter, with a broader black ring, and elevated. The stroma ruptures the overlying epidermis, and ultimately crumbles and falls out, leaving a black cavity. Mature stromata are black (dark brown or red brown in section by transmitted light), and contain from one to four perithecial cavities, up to 0·3 mm. diameter. The spores are oval, hyaline, continuous, 20–24 × 8–12 μ. They are evidently ascospores, but the asci are either soon diffluent, or broken in these specimens, and only fragments of them have been observed.

In Thwaites 358, the ring spots are not arranged in any definite order, but they are more crowded than in Thwaites 356. The fungus is in a more advanced condition than in the latter, and the stromata show perithecial cavities, but they are immature.

This fungus is a *Botryosphaeria*. It is apparently identical with *Botryosphaeria Agaves* (P. Henn.) Syd. (*Physalospora Agaves* P. Henn.), but I have not seen authentic specimens of the latter.

323.—Diplodia radula B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 785, as "Peritheciis minutis epidermidem albifactam elevantibus, ostiolis distinctis ; sporis ellipticis (No. 305). On Musaceae.

Spores ·001 inch long, narrower than in the next species (*i.e. Diplodia circinans*), dark, with a wedge-shaped pedicel."

In recent specimens, on decaying leaf stalks of plantains, the pycnidia are 0·2–0·3 mm. diameter, scattered or clustered, immersed, elevating the epidermis in minute, white points. The spores are ellipsoid or oblong-oval, not constricted at the septum, 24–28 × 11–14 μ. The basidia are short and stout, up to 16×5 μ, sometimes attenuated upwards. Numerous linear paraphyses are present, up to 100 μ long and 2 μ diameter.

Grove, in Kew Bulletin, 1921, p. 143, suggests that this species is identical with *Macrophoma Musae* Berl. and Vogl., and possibly with *Botryodiplodia Theobromae* Pat. In spores and paraphyses it is indistinguishable from the latter, but the basidia appear to be stouter. It is, however, quite different from *Macrophoma Musae*, which has prominent stromata crowded on the living green tissue and making it appear rough. *Macrophoma Musae*, in the specimens collected in Ceylon, does not develop into a *Diplodia*.

324.—Diplodia zeylanica Tassi, **Diplodia striata** Tassi, **Diplodia Hurae** Tassi

In Bull. Lab. Ort. Bot., Siena, II, (1899) p. 154, F. Tassi described *Diplodia Hurae*, on seeds of *Hura crepitans*, and *Diplodia striata* on seeds of *Tectona grandis*, both from Ceylon; while in vol. III of the same journal, (1900), p. 19, he added *Diplodia zeylanica* on seeds of *Cyathocalyx zeylanicus* from Ceylon.

Diplodia zeylanica had pycnidia scattered or gregarious, 0·5–1 mm. diameter; spores, 25–26×12 μ; and numerous paraphyses, three or four times as long as the spores.

Diplodia striata had pycnidia, 0·3 mm. diameter; and spores, 18–20 × 12 μ, longitudinally striate. Paraphyses are not mentioned.

Diplodia Hurae had pycnidia 0·3–0·5 mm. diameter; and spores, 24–26 × 12 μ. The description does not refer to paraphyses.

The common *Diplodia* on decaying seeds or fruits in Ceylon is *Botryodiplodia Theobromae* Pat. In the case of dehiscent fruits which have a certain amount of pulp between the seeds, *e.g.*, *Cullenia excelsa*, this species will develop in abundance between and on the surface of the seeds, if the fruit is prevented from dehiscing completely when ripe, as is usually done with museum specimens. From the description, it would appear most probable that *Diplodia zeylanica* is identical with *Botryodiplodia Theobromae*. With regard to the other two species, the dimensions of the spores would not exclude them from *Botryodiplodia Theobromae*, but the descriptions do not mention paraphyses. As, however, very many

of the descriptions of *Botryodiplodia Theobromae* have been similarly deficient, the types of these two should be re-examined with that point in view.

325.—Pestalozzia congesta B. & Br.

In Fungi of Ceylon, No. 805, Berkeley and Broome described *Pestalozzia congesta* from Thwaites 511, as "Cellulis congestis prominulis brunneis ; sporis oblongis uniseptatis. On underside of leaves of *Syzygium Jambolanum*. Peradeniya, Feb. 1868. Forming little brown patches about a line wide." *Syzygium Jambolanum* DC. is *Eugenia Jambolana* Lam.

In the specimen in Herb. Peradeniya, the leaf bears minute, pulvinate, black elevations, about 0·5 mm. diameter, crowded together in groups up to 2 mm. diameter. The acervular loculi are lenticular, up to 250 μ broad and 100 μ high, on either side of the leaf, but chiefly on the lower, and do not open widely. The spores are borne on stout hyaline basidia, 6–18 μ high, expanding to 2 μ diameter at the apex, and are oval or subcymbiform, rather pale brown, one-septate, usually not constricted at the septum,rounded or truncate below, rounded at the apex, 17–26 × 8–10 μ. At the apex of the spore are from two to four, usually three, hyaline flexuose cilia, up to 32 μ long. There is no apical or basal hyaline cell, and no persistent hyaline pedicel.

When Saccardo listed *Pestalozzia congesta* in Sylloge Fungorum, III, p. 786, he added the comment, "Si conidia vere 1-septata, an novi generis typus ?." Subsequently he instituted the genus *Barklayella* for a one-septate *Pestalozzia* described by Ellis and Everhart, and later altered the generic name, which had been antedated, to *Neobarclaya*. He did not, however, include *Pestalozzia congesta* in his new genus. The Ceylon species is evidently *Neobarclaya*, and will stand as *Neobarclaya congesta* (B. & Br.).

An immature Pyrenomycete, apparently a *Micronectria*, accompanies the groups of acervuli.

Sydow has recorded *Neobarclaya natalensis* on *Eugenia Jambolana* from India.

326.—Gymnosporium confusum B. & Br.

Gymnosporium confusum was described by Berkeley and Broome in Fungi of Ceylon, No. 813, as "Effusum, nigrum ; sporis magnis subglobosis. With *Monotospora fusigera*. Spores ·0001–·0008 in diameter." In Saccardo, IV, p. 245, it was listed as *Coniosporium*. *Monotospora fusigera*, Fungi of Ceylon, No. 891, was said to be apparently on the leaves of some palm.

The fungus in the type is apparently on bamboo. The substratum is covered with a thin black powdery mass, which is composed chiefly of the hyphae and spores of the *Monotospora* intermixed with the spores of the *Gymnosporium*. On scraping off this surface layer, it is found that the *Gymnosporium* forms linear acervuli, up to 5 mm. long, 0·2–0·3 mm. wide, which develop beneath the outer layers of the host tissue and either split them longitudinally, so that the acervulus is bordered by the upturned epidermis, or cut out an oval scale, up to 1 × 0·3 mm.

The spores are biconvex, circular, 16–24 μ diameter, or oval, 17-32 × 14–24 μ, pale brown, thin-walled, minutely granular. There are slight indications of a paler edge, but the spores are not mature enough to show it definitely. It is probable that the spores have been affected by the *Monotospora*.

This species is a *Melanconium*, and will stand as *Melanconium confusum* (B. & Br.). In the formation of a scale, it resembles *Melanconium circumcissum* and *Melanconium Dendrocalami*. The former has smaller spores, but the latter is doubtfully distinct from *Melanconium confusum*.

327.—Gymnosporium lineare B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 814, as " Soris linearibus e cuticula bilabiatis ; sporis obovatis brevissime stipatis (No. 506). On *Andropogon muricatum*, March, 1868. Spores ·0005 long. " The specimen, Thwaites 506 in Herb. Peradeniya, is marked on " *Andropogon muricatus*, Damboul." In Saccardo, IV. p. 243, it is listed as *Coniosporium lineare* (B. & Br.)

Andropogon muricatus of Thwaites is *Andropogon muricatus* Retz., which is *Andropogon squarrosus* L. f. of Flora British India and Flora of Ceylon. It is now known as *Vetiveria zizanioides* Stapf.

The fungus is on the leaves of the grass, on which it forms black linear sori, up to 7 mm. long, on the under surface. The sori are bordered by the upturned tissues of the host, which gape rather widely, and have frequently a strand of the host tissue running along the centre from end to end. The leaf of *Vetiveria* consists of an upper and a lower layer of tissue united by transverse pillars, and thus contains large longitudinal air spaces. The fungus occurs in these air spaces, each sorus being confined to one of them, and it ruptures the thinner lower surface of the leaf. Frequently the rupture occurs along both sides of a vascular bundle, and the tissue containing the vascular bundle then persists as a longitudinal strand.

The spores are black in mass and completely fill the cavity for the length of the sorus. When viewed by transmitted light, they are

blackish-brown, very minutely warted or smooth. They are irregularly globose, quadrangular, or pentagonal, 6-10 μ diameter, with many irregularly oval spores of double that size, 13-16 × 8-11 μ. There are no basidia.

This is evidently an *Ustilago*, somewhat immature, and will stand as *Ustilago linearis* (B. & Br.). It does not appear to be markedly different from *Ustilago occulta* P. Henn, recorded on culms of *Andropogon* sp. from Brazil (1897), in which the spores are said to be 6-8 × 6-7 μ, with a minutely verrucose epispore.

Sydow has described *Ustilago effusa*, on *Andropogon muricatus* from India. It occurred on the leaves, sheaths, and culms. The sori are described as " longe lateque effusis ", and the spores as " minutissime verruculosis, 3·5-5 μ diameter. " The host plant would appear to be the same as the Ceylon species, but from the description the fungus would seem to be different

328.—Gymnosporium circumscissum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 811, as " Maculae oblongae ; cuticula circumscissa ; sporis niger-rimis globosis vel subglobosis laevibus (No. 1050). On bamboo. Peradeniya, Jan. 1869. Spores ·0003 long." In Saccardo, IV, p. 224, it was transferred to *Coniosporium*. Grove, in Kew Bulletin, 1918, p. 174, re-described it as *Melanconium circumscissum*.

The pustules are subepidermal, and the overlying epidermis breaks away as an oval scale when the pustule is mature. Sometimes the scale first splits down the centre, while in other cases it cracks radially into four. The pustules are circular or oval, 0·4-1·2 mm. long, 0·4-0·5 mm. broad. The spores are brown, circular in plan, 6-8 μ diameter, biconvex, with a pale margin which appears as a longitudinal band as the spore rolls over.

Melanconium Dendrocalami Petch has the same habit, but its spores are much larger, 20-24 μ diameter. In all other respects the two are the same.

329.—Oidium gilvum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 895, as " Placentiforme, gilvum ; sporis obovatis e pedunculo tenui moniliformiter oriundo (No. 664). Looks at first sight very like an *Hypocrea* ; often crowded together, a line or more across, rather compact." In Saccardo, it was transferred to *Oospora*.

There are specimens in Herb. Kew and Herb. Peradeniya. The specimen in the latter herbarium consists of five pieces of bark, one of

which bears three minute, brown, placentiform stromata. These stromata are about 1 mm. diameter, and 0·7 mm. thick, compact, with a distinct cortex; they appear to be immature *Hypocrea*. The other four pieces do not bear any of these stromata. All the five pieces have minute white tomentose patches in cracks in the bark, which may be the bases of tufts of a hyphomycete, but nothing definite can be made of them. No obovate spores have been found.

Since Thwaites retained five pieces, only one of which bears brown stromata, one is led to imagine that there may have been present originally a hyphomycete which has since disappeared almost entirely through periodic preservation. Berkeley and Broome's description might then refer partly to the stromata and partly to the hyphomycete. " Placentiforme, gilvum " is a correct description of the immature *Hypocrea*; but the remainder of the description does not apply to anything now present.

Unfortunately the details given are too meagre to enable anyone to decide what the obovate spores were, and hence it would appear preferable to discard the name altogether.

During recent years the name *Oospora gilva* (B. & Br.) has been applied in some countries to the very common pink hyphomycete which develops freely on charred sticks in the Eastern Tropics. As has already been pointed out by Miss Wakefield, that hyphomycete is *Monilia carbonaria* Cooke, and it is probably identical with the conidial stage of *Melanospora erythraea*, described by Möller from Brazil. There is no trace of charring on the type specimen of *Oidium gilvum*.

330.—Fusidium squamicola B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 877, as " Luteum, floccis erectis ramosis, sporis oblongis brevibus (No. 441). On leaves of *Clerodendron*. Spores 5-9 μ long." They added the note, " It may perhaps be thought that this is only a morbid condition of the scales. This can be determined only on the spot; but at any rate it is worth recording."

The fungus has been collected recently on leaves of *Clerodendron fragrans*. It occurs on the under side of the leaf and apparently attacks the scales only. It appears first in minute tufts at the edge of the scale, with a few simple stout conidiophores, and subsequently covers the scale with a white loose mass, about 0·25 diameter, consisting of hyphae and conidiophores intermixed. The conidiophores are up to 50 μ high, branched; the branches are opposite, stout below, attenuated upwards, or narrow flask-shaped. The conidia are terminal, solitary, hyaline, narrow-oval or oblong-oval, ends acute, 3-5 × 1·5-2 μ.

Berkeley and Broome's "Luteum" is the colour of the scale. Their specimens are in an early stage, and show minute tufts, up to 100 μ broad and 30 μ high, projecting to the number of three or four from a scale. The conidiophores are simple, or once branched, stout, and obtuse at the apex. No spores 9 μ long have been found in the type; Berkeley and Broome may have measured a developing branch.

This species appears to be *Monosporium*, and will stand as *Monosporium squamicolum* (B. & Br.).

331.—**Sporodum effusum** B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 898, as "Strato atropurpureo effuso; floccis erectis hic illic monilia solitaria vel congregata e processu laterali ferentibus (No. 245). On the petioles of fallen leaves. Spores globose ·002 (inch) diameter." In Saccardo, Sylloge Fungorum, IV, p. 308, it was listed as *Dematium*, the spores being given as 5 μ diameter. On the drawing with the type specimen in Herb. Kew the spore is said to be 0·0002 inches.

The type specimen is on bamboo. The fungus forms dark purple-brown effused patches spreading over several centimetres. In the herbarium specimen, these patches are flattened, and consist of sheets of interwoven or depressed hyphae, 0·3 mm. thick. The basal layer is superficial, compact, 50—80 μ thick, and from this there arise flexuose, purple-brown hyphae, simple or branched, up to 200 μ long, 3-4 μ diameter, equal, septate, rather thick-walled, minutely verrucose. These hyphae bear short lateral branches at wide distances, either simple, oval, about 8 μ long, or elongated, one septate, constricted at the septum, up to 25 μ long. The conidia are borne in clusters at the apices of the short branches or at the apices of the long hyphae, and are globose, 3-4 μ diameter, red-brown, minutely verrucose.

This species is a *Trichobotrys*, and will stand as *Trichobotrys effusa*. Except in colour, it does not appear to differ from *Trichobotrys pannosa* Penz. and Sacc., judging from the figure and description of the latter. The colour of *Trichobotrys pannosa* was said to be "ex olivaceo nigricans."

332.—**Mesobotrys graminicola** (B. & Br.) Sacc.

Coniosporium cinctum (B. & Br.) Sacc.

In Thwaites 505, on *Andropogon*, Berkeley and Broome found two species, *viz.*, *Sporodesmium tessarthrum* B. & C., and *Chaetopsis graminicola* B. & Br. Another specimen on *Andropogon* was subsequently sent by Thwaites (No. 1140) and was marked by him, "sent before with No. 505," but Berkeley and Broome recorded it as *Gymnosporium cinctum* B. & Br.

Sporodesmium tessarthrum was originally described from Cuba. It was recorded for Ceylon in Fungi of Ceylon, No. 808, on *Andropogon*, March 1867 (Thwaites 505).

Chaetopsis graminicola B. & Br. was described in Fungi of Ceylon, No. 810, as "Sporis globosis quaternis laevibus (No. 505 in part). On leaves of *Andropogon*. Main filament subulate, articulated, dark below, nearly hyaline above; spores globose, four together at the tips of the lateral basal threads. Habit exactly that of *Chaetopsis Wauchii* Grev." In Saccardo, IV, p. 325, it was transferred to *Mesobotrys*, as *Mesobotrys graminicola* (B. & Br.).

Gymnosporium cinctum B. & Br. was described in Fungi of Ceylon, No. 812, as "Sporis globosis aterrimis, floccis erectis septatis cinctis (No. 1140). On leaves of *Andropogon muricatum*. Damboul, Nov. 1868. Spores ·0002 in diameter. Exactly the habit of *Excipula*; but the spores are totally different and resemble those of *Gymnosporium*." In Saccardo IV, p. 243, it was listed as *Coniosporium cinctum* (B. & Br.), with the suggestion that it might be *Myrothecium* or *Chaetostroma*.

In Herb. Kew, Thwaites 505 is included under *Spegazzinia tessarthra*; there is no specimen of *Chaetopsis graminicola* so labelled, but the *Spegazzinia* specimen contains both species. In Herb. British Museum the converse holds; Thwaites 505 is included under *Mesobotrys graminicola*, with Broome's drawing, is marked "*Chaetopsis graminicola* growing with *Sporodesmiun tessarthrum*." and contains both species.

The specimen of *Gymnosporium cinctum* in Herb. Kew is. as already stated, marked by Thwaites, "sent before with No. 505."

The species assigned to *Sporodesmium tessarthrum* B. & C., now known as *Spegazzinia tessarthra* (B. & C.) Sacc., appears to be correctly named. But *Chaetopsis graminicola* and *Gymnosporium cinctum* are identical, as Thwaites suggested.

Chaetopsis graminicola is superficial, forming black, oval or irregular patches up to 2·5 mm. long and 0·5 mm. wide, which consist of a purple-brown, or black, pulverulent basal mass from which arise numerous rigid, black, erect setae. These setae arise from all parts of the patch and are not confined to the margin; they are up to 1·5 mm. long, 12 μ diameter below, tapering upwards, regular, black, becoming brown above and sometimes hyaline at the apex, with an obtuse apex, septate, the septa only visible in the lighter coloured parts. The basal layer of the fungus is an irregular, thin network of contorted, olivaceous hyphae, 1·5-3 μ diameter, from which the barren setae arise. Between the setae and arising from the same network are erect, regular, simple, pale brown, or subhyaline, septate conidiophores, up to 75 μ high and 3 μ diameter, which are strongly verrucose and bear conidia apically and laterally.

the conidia are globose, 4-5 μ diameter, or oval, 4-5 × 3 μ. yellow-brown to dark brown, minutely verrucose.

Berkeley and Broome's description, it will be noted, distinguished between the "main filaments," *i.e.* the barren setae, and the "lateral basal threads," which are the conidiophores; but the use of the term lateral was misleading in suggesting that the conidiophores were branches of the setae. They probably meant that the conidiophores were situated at the side of the setae, *i.e.* between them. The conidia occur in groups only by accident after abscission, and they are minutely verrucose under a high magnification.

It is difficult to understand how Berkeley and Broome came to make another species out of Thwaites 1140, especially in view of Thwaites' note. The fungus in the type of *Gymnosporium cinctum* is exactly the same as *Chaetopsis graminicola*, is quite superficial, and though its conidia are black in mass to the naked eye, they are brown by transmitted light. The setae do not surround the patch, but are scattered irregularly through it. The dimensions given by Berkeley and Broome for the conidia agree with those of the fungus examined, and there does not appear to be any other species in the specimen to which Berkeley and Broome's description could be applied.

Gymnosporium cinctum is consequently identical with *Chaetopsis graminicola*. It appears to agree well with *Lacellina* Sacc. (Ann. Myc., XI, p. 418), and will stand as *Lacellina graminicola* (B. & Br.).

333.—**Sporodesmium polymorphum** Cda.

This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 809, from Thwaites 1030, the specimen being on dead wood.

In the specimen in Herb. Peradeniya, Thwaites 1030, the fungus forms thin, effused, compact, black patches. The hyphae or conidiophores are up to 70 μ high and 3–4 μ diameter, black-brown, or dark brown, septate, equal or moniliform, sometimes dividing above into two or three branches. They bear terminal spore clusters, or compound spores in chains, linked by short, septate hyphae, or almost in contact. From one compound spore, three chains of compound spores may arise. The compound spores are black and opaque, irregularly oval, 18–24 × 13–16 μ or irregularly globose, about 18 μ diameter. On heating with lactic acid or caustic potash, they become slightly more translucent, and then separate to some extent under pressure. The individual cells are polyhedral, rounded exteriorly, and 4-8 μ diameter. The compound spore is at first spherical, about 9 μ diameter, divided (in plan) by two diameters at right angles.

This fungus is evidently *Sirodesmium*, and it may be known as *Sirodesmium opacum* n. sp.

334.—Septonema olivaceo-nigrum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 806, as " Pulvinulis tomentosis olivaceo-nigris congestis ; sporis 4-articulatis, articulis globosis, echinulatis e floccis ramosis articulatis oriundis (No. 248). Apparently on leaves of *Agave*. Spores ·0008 long."

This fungus in the type forms lax tufts, about 0·2 mm. diameter, with a pseudoparenchymatous base. These extend and become confluent in purple-black, effused masses. The hyphae are brown or black-brown, 4 μ diameter, regular, rigid, septate, smooth, much branched. The conidia are catenulate, either one-septate, oblong, with rounded ends, strongly constricted at the septum, black-brown, verrucose, 8–11 × 4--5μ, or three-septate, slightly constricted, sometimes only slightly verrucose, 14–28 × 5 μ.

335.—Triposporium Gardneri Berk.

This species was sent to Berkeley by Gardner in 1848, and formed the subject of " A notice of a mould attacking the coffee plantations in Ceylon," in Jour. Roy. Hort. Soc., IV (1849), pp. 7, 8. Berkeley there referred to it as *Triposporium Gardneri* and gave a figure, but he did not publish a description until 1873, in Fungi of Ceylon, No. 894. The description given there is " Olivaceum ; floccis fertilibus erectis articulatis, articulis constrictis ; sporis 6-8-septate acutis, apice hyalinis. On the under side of dead leaves. July 1848."

In his first notice, Berkeley stated. "The leaves are completely covered with a black sooty wash, and the trees must be in a sad plight ; for not only are they smothered with the fungus, but they are weighed down with masses of a gelatinous lichen belonging to the genus *Collema* or some closely allied group, which, though merely forming small radiated black specks when dry, on the application of moisture instantly swells and increases immensely in volume. Mr. Gardner's observation that the fungus is always preceded by an insect is exactly in accordance with what often takes place in similar affections here."

Gardner wrote a " Report on the Brown Scale, or Coccus, so injurious in the coffee plants in Ceylon," in which he referred to the fungus as an *Antennaria*, and gave figures. This appeared in Hooker's London Journal of Botany, II (1850), pp. 353-360, and III (1851), pp. 1-9 ; and was re-published in Ceylon in 1885. Gardner stated " As certainly as

the scale never appears on the upper surface of the leaf, so surely does the *Antennaria* or fungus never appear on the under one."

The fungus occurred on living leaves, and on the upper surface. The type specimen shows the usual accumulation of species found on the upper side of smooth leaves, *e.g.*, *Cinnamomum ovalifolium*, following scale insects, in up-country districts. The black specks referred to by Berkeley are an *Atichia*, probably *Atichia Millardeti*, which frequently occurs in such situations, and there is also a Trichopeltaceae present. The mycelium on the leaf forms a thin membrane, consisting of a network of olivaceous hyphae, 5–12 μ diameter. The hyphae are verrucose, regular, or closely septate, constricted at the septa and moniliform. The conidia are scanty and often broken; the arms of the spores now present are up to 64 μ long, 14 μ diameter at the base, with septa 12–16μ apart, sometimes even, sometimes strongly constricted and moniliform. Berkeley's figure shows the arms nine times as long as broad, with a hyaline, non-septate tip, up to one-third the length of the arm. The specimen is not now in good condition, and probably the larger spores have been brushed off. Berkeley stated that the spores were sometimes elongated at the apex and proliferous, and he figured that condition. It would seem probable that the latter figure represents mycelium only.

Gardner's figures show only mycelium. His figure 14, "a branch bearing seeds," is a hypha with a foreign body attached to it.

336.—Arthrobotryum curvulum (B. & Br.) Sacc.

This species was described by Berkeley and Broome under the name *Graphium curvulum* in Fungi of Ceylon, No. 901. The brief description is "Sporis curvulis elongatis 6–7 septatis." It was Thwaites 342 and was said to occur on bark with *Thelephora pedicellata*. In Saccardo, Sylloge Fungorum, IV, p. 629, it was listed as *Arthrobotryum*. Thwaites 342 provided the specimen which was recorded in Fungi of Ceylon, No. 574, as *Thelephora pedicellata* Schw.

There is no specimen marked *Graphium curvulum* or *Arthrobotryum curvulum* in Herb. Kew or Herb. British Museum. Thwaites 342 was apparently included under *Thelephora pedicellata* only.

An examination of the specimen, Thwaites 342, in Herb. Kew and Herb. Peradeniya has failed to disclose any *Arthrobotryum*. The hair-like pillars which fringe the stroma are, of course, the pillars of the *Septobasidium* (*Thelephora*). Among the hyphae of the stroma, however, there occur a few hyaline, elongated, septate spores which are undoubtedly the conidia of a *Microcera*, and it would seem probable that these spores provided the description of *Graphium curvulum*. It will be noted that Berkeley and Broome did not describe anything except the spores.

" *Septobasidium pedicellatum* "is parasitic on colonies of scale insects. It frequently happens that some of the insects have been previously killed by *Microcera*, *Tuberculariа*, etc., and in that case the *Septobasidium* grows over scale and fungus alike, the fructifications of the *Microcera* generally penetrating the *Septobasidium* if only the basal layer of the latter has been developed. I have not been able to find the synnemata of *Microcera* in Thwaites 342, but there can be little doubt that that has happened in this case. As it is not possible to decide to which *Microcera* the conidia belong, the name *Arthrobotryum curvulum* should be discarded.

337.—Dinemasporium gelatinosum B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 797, as " Superficiale, in epidermide nigra insidens ; sporis hyalinis magnis fusiformibus ellipticisve (No. 556). On dead twigs. Central Province, Feb. 1868. Spores ·0013 long."

In the specimen, Thwaites 556, in Herb. Peradeniya, the fungi are on pieces of a dead twig, and each arises from a small black spot. The spores agree in general shape with those of *Chaetospermum tuberculariοides* Sacc. (=*Tuberculariа chaetospora* Pat., Bull. Soc. Myc. France, IV, p. XL), and, Berkeley and Broome's description making no mention of the appendages, it was re-described in Ann. Perad., VI, p. 255, as *Chaetospermum gelatinosum* Petch. It will now stand as *Chaetospermum gelatinosum* (B. & Br.) Petch. The following description, based on fresh specimens, is repeated from Ann. Perad., *loc. cit.*

The sporodochia are subgelatinous, cylindric, up to 0·6 mm. high, 0·4 mm. diameter, with the base immersed in the substratum. The outer layers are composed of parallel hyphae, 3 μ diameter, which form a sheath and become gelatinous. The inner hyphae terminate as simple conidiophores, up to 30 μ high, 3 μ diameter, with terminal conidia, and are mixed with paraphyses, up to 80 μ long, 2 μ diameter, slightly thickened at the apex. The conidia are oval, inequilateral, or subcymbiform, hyaline, with granular contents and a stout wall, 1·5 μ thick, and measure 36–44 × 16–21 μ. At each end of the spore there is a tuft of six to twelve filaments, up to 80 μ long and 1 μ diameter, while along the more convex side of the spore are short filaments up to 10 μ long, or capitate appendages up to 4 μ long.

338.—Stilbum stromaticum Berk.

This species was described by Berkeley in Hooker's London Journal of Botany, II (1843), p. 642, from specimens collected by Gardner in Brazil, the description being, " gregarium, e stromate nigro inaequali ;

stipitibus compressis striatulis nigris ; capitulis aureis globosis ; sporis minutissimis subglobosis. Forming effused patches on the bark, springing from a black, smooth, undulated stroma, which has exactly the structure of a Sclerotium, consisting of angular cells, each of which contains a nucleus, those of the cuticle being darker and smaller. Stems distinct, 1·5–3 lines high, 1/8 of an inch thick, compressed, black, consisting of very fine fibres, externally slightly striate, surmounted by a yellow globule, which is coated with very numerous, extremely minute, subglobose spores."

It was subsequently recorded by Berkeley and Broome for Ceylon, in Fungi of Ceylon, No. 866, from Thwaites 1224, collected below Adam's Peak, February 1871. There are specimens of the latter collection at Kew and at Peradeniya. The date on the specimen in Herb. Peradeniya, Thwaites 1224, is February 1870, but it is undoubtedly part of the same gathering as that in Herb. Kew.

Bresadola (*fide* von Höhnel) redescribed the Brazilian species in Hedwigia, 1897, p. 302, which is not at present accessible to me. von Höhnel gave a full description of specimens from the same country in Eumycetes et Myxomycetes, Ergebnisse der Bot. Exped. der kaiserl. Akad. der Wissenschaft. nach Sudbrasilien, 1901, and transferred it to a new genus *Stromatographium*, as *Stromatographium stromaticum* (Berk.) v. H.

The Ceylon specimens contain two forms. In the one form, the stromata are superficial, up to 5 mm. diameter, black, thin, glabrous, irregularly furrowed and tuberculate, somewhat fleshy, not brittle, about 200 μ thick, brown internally, parenchymatous, with cells up to 10 × 6 μ. From these arise numerous synnemata, up to 4 mm. high, black, glabrous or minutely pruinose, sometimes longitudinally furrowed, up to 0·15 mm. diameter at the base, tapering to 0·075 mm. diameter at the apex. The heads are now yellow, subtranslucent, about 0·3 mm. diameter. When viewed by transmitted light, it is seen that the stalk terminates in a pale brown zone, while the centre of the head is dark brown. The conidiophores form a translucent zone 50 μ deep round the brown centre ; they are closely crowded, hyaline, filiform, branched, curved above, and bear minute hyaline conidia, either oval, 1·2 × 0·75 μ, or globose, 0·75 μ diameter. The conidia are agglutinated into a solid mass round the head. A few conidiophores are longer than the rest, and project beyond the hyaline palisade zone.

With these are a few other examples which at first sight appear quite different. These are fasciculate, with no evident stroma, or a slight stroma on one side of the group. They are up to 5 mm. high, with flattened stalks, up to 1 mm. broad below, flask-shaped or attenuated up-

wards. The stalk is rough with minute protuberances, especially towards the apex. The head is black, laterally compressed, reniform, 1·2 mm. broad, 0·4 mm. high, descending about 0·3 mm. on either side of the stalk and well defined from it. In section, the centre is pale brown, surrounded by a dark brown zone about 50 μ broad, and an outer compact layer of conidiophores, of about the same breadth. The conidiophores and conidia are the same as in the slender examples, but there is a larger number of elongated conidiophores, up to 180 μ long. There does not appear to be any doubt that these are merely larger examples of the same species.

The Ceylon form differs from the Brazilian, judging from von Höhnel's description, only in its thinner stroma. Berkeley evidently correctly referred the two collections to the same species.

339.—Isaria arcyrioides B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 864, as "Stipite nigro sulcato in capitulum clavatum desinente; sporis metulaeformibus angustis pallidis (No. 122). Spores 12·5–18·75 μ long, one-third as much broad in the centre."

It has been found recently on decaying wood at Hakgala. The surface of the wood is blackened. The synnemata are clavate, up to 2·5 mm. high. The stalk is black, and the head grey, loose, ovoid or cylindric. The stalk in some cases is stout, 0·5 mm. diameter, and its constituent hyphae separate above to form the head; in other cases, it is slender, 0·2 mm. diameter, and is continued above as a columella in the centre of a cylindrical head. The conidiophores are branched, the ultimate branches being long and slender, and about 2 μ diameter, with terminal conidia. The conidia are hyaline or slightly fuscous, narrow-oval, with acute ends, 8-14 × 3–4 μ.

340.—Isaria aurantiaca B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 860, as "Congesta, lateritio-aurantiaca. cylindrica vel compressa, subramosa, radians; sporis curvis (Nos. 253, 334). On bark and decorticated branches. Nuwara Eliya. Bright orange; about a line high; spores 0·0004 long." The second number should be 344. Thwaites 334 is *Grandinia lateritia*, Fungi of Ceylon, No. 561.

No. 253 was collected at Peradeniya on wood, and No. 334 at Hakgala on bark. The two fungi are totally different. No. 253 consists of minute black stromata, with a carbonaceous crust, deep red-brown internally. Some of these are broken and display the colour of the interior, while others bear Stilbum-like processes which may be a coni-

dial stage, or developing ostiola. Nothing matching this has been collected recently. On the other hand, No. 344 has been collected on several occasions during the last fifteen years in the Botanic Gardens, Hakgala, where it is nearly always to be found on some old specimens of *Apodytes Gardneriana*, relics of the former jungle ; it grows on the decaying bark scales of the living trees, not on wood. The description of *Isaria aurantiaca* was apparently drawn up from Thwaites 344, and hence the specific name is retained for the latter fungus. Thwaites 253 is immature and unrecognisable. The following description relates to *Isaria aurantiaca*, Thwaites 344.

The individual clavae are orange yellow, clavate or fusoid, subacute at the apex, about 2 mm. high, 0·4 mm. diameter, more or less tomentose, and rarely forked. They are rather loosely built of hyphae 2–4 μ diameter, which are encrusted with minute yellow granules. They occur crowded together in small clusters, more or less radiating from a centre, or in long lines in cracks in the bark. They arise from a yellow mycelium within the bark, but are very slightly attached and readily fall off. I have examined these clavae on many occasions, but have not been able to find any spores on them.

Arising among the clavae already described there occur others up to 1 cm. high, 0·6 mm. diameter below, greyish yellow, forked at about half their height, the branches forking again into comparatively long, simple, terete, acute tips. This is a *Lachnocladium*. It is composed of hyphae similar to those of the simple fusoid clavae, and all stages between the latter and the fully-developed *Lachnocladium* occur. The spores are white in mass, pale yellow when magnified, smooth, oblong-oval, inequilateral, 7–11 × 3–5 μ. It will be known as *Lachnocladium aurantiacum*.

The simple barren clavae occur in large numbers, but the fully-formed *Lachnocladium* is comparatively rare. There is no evident reason why the barren clavae should be produced in such profusion, and no similar case appears to have been recorded with regard to any other species of *Lachnocladium*.

341.—**Isaria pulcherrima** B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 863, as " Alba, clavata, deorsum filiformis, villosa, e mycelio byssoideo quandoque repente oriunda, floccis fertilibus articulatis : sporis ex articulis enatis verticillatis (Nos. 219, 249). On fruit and leaves of palms. Sometimes scattered, sometimes crowded ; spores subglobose, ·00015 (inch) long." They gave figures, showing the conidia arranged in rings round the conidiophores.

In the type specimen, the synnemata are white or cream-coloured, up to 1·5 mm. high, scattered or somewhat clustered. Each arises from a small circular byssoid patch, and these patches may be confluent, but the " somewhat repent mycelium " noted by Berkeley and Broome consists rather of decumbent and weathered synnemata. The head is cylindric, about 0·4 mm. diameter and one-third the total height, or shorter and clavate. The stalk is about 0·1 mm. diameter, loosely fibrillose externally, with hypha of the same character as the conidiophores ; when mounted, it appears yellow, and is continued almost to the apex of the head as a yellow columella.

The head is composed of rather loosely arranged conidiophores which spread at a small angle from the columella. The conidiophores are thick-walled, 2 μ diameter below, with clavate tips, up to 4 μ diameter ; they are closely septate, especially above, where the septa may be only 6 μ apart. The apical cell is more or less ovate, sometimes acute above. The sterigmata are scarcely-elevated protuberances, up to 0·75 μ high ; they occur anywhere along the conidiophore, or in a ring just below a septum, or scattered over the terminal cell. I have not seen any as long as those figured by Berkeley and Broome in their figure b. The old conidiophores are verrucose, probably with sterigmata.

The conidia are globose, 3–3·5 μ diameter, or broadly oval, 3 × 3·5 μ, hyaline, thick-walled, minutely verrucose.

Berkeley and Broome's figures are substantially correct. *Isaria cocoa* Lloyd, in Myco. Notes, No. 62, p. 925, would appear to be the same species.

342.—Actiniceps Thwaitesii B. & Br.

The genus *Actiniceps* was established by Berkeley and Broome in Jour. Linn. Soc., XV, p. 85. The description of the genus is " Stipes hyalinus, e floccis congestis in capitulum globosum radiantibus, hic in spiculas conicas vitreas granulatas desinentibus, illic in ramulos tenerrimos ; sporae minutissimae." The species, *Actiniceps Thwaitesii*, was said to grow on dead coriaceous leaves, and to have a stem 0·017 (inches) high, and head 0·0065 (inches) diameter, with spicules " more like the parts of a sponge than of a fungus."

Berkeley and Broome gave figures of the entire fungus, the hyphae of the stem, a spicule, and a conidiophore with conidia.

In a part of the type specimen from Herb. Kew examined by me, the stalk is about 220 μ high and 62 μ diameter, slightly expanded at the base, equal, smooth, and composed of parallel thick-walled hyphae. The head is globose, about 0·1 mm. diameter. The spicules arise from, or are in continuation of, the outer hyphae of the stalk. In general, the spicules are broken : they are 8 μ diameter at the base, with an in-

ternal flask-shaped cavity, tapering, and minutely granular. In the centre of the head are the branched bases of the conidiophores, which are also granular. Conidia were not found.

In specimens recently collected at Peradeniya on dead leaves, the stalk is about 200 μ high and 60 μ diameter, pale brown becoming white above. The head is obconoid, about 0·2 mm. diameter, pale yellow. The hyphae of the stalk are thick-walled, but the outer layer is rather loose, and there is frequently a collar on the stalk below the head. All the spicules are marginal, *i.e.* they form a fringe round the lower edge of the head. The spicules are up to 300 μ long and 5 μ diameter at the base, with a minute central cavity, tapering regularly to the apex which is usually obtuse, smooth, thick-walled. The central hyphae of the head (conidiophores) branch repeatedly, all the branches being straight and at an acute angle, and terminating in slender simple basidia. The conidia are rod-shaped or narrow-oval, hyaline, continuous, 4–6 × 1 μ.

Berkeley and Broome's figure is incorrect in showing the spicules scattered over the head. Their specimens were evidently old and weathered, and had lost the looser outer layer of the stem, while their description and figure of the conidiophore and conidia apparently refer to some intrusive mould.

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The genus Cyanotis in Ceylon

BY

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Sir J. D. Hooker, in Trimen's Flora of Ceylon, IV, (1898), p. 311, made the following note. " The species of *Cyanotis* are so very variable in habit and pubescence that probably more Sinhalese specimens than I have had access to are wanted to describe the following species satisfactorily." In view of this statement a large number of Ceylon specimens was collected and examined, and in this examination several errors were found in the descriptions of the Ceylon species. The key on p. 311 of the Flora needs correction in accordance with the differences observed. Only those species which have been wrongly described are re-described below, characters common to the several Ceylon species being enumerated under the generic characters.

CYANOTIS Don

Annual or perennial herbs.

Roots fibrous, profuse, usually adventitious at the nodes, turning purple if exposed above the surface.

Stem profusely branched, creeping, decumbent, or erect, usually rooting at the nodes, often differentiated into foliage shoots and flowering shoots.

Leaves alternate, sessile, linear or linear-oblong to lanceolate ; base sheathing.

Flowers in axillary and terminal, scorpioid, bracteate cymes, enclosed in more or less falcate, imbricating, biseriate, secund, foliaceous bracteoles, only the petals and stamens exserted ; in *C. axillaris* the cymes are reduced to axillary fascicles of flowers within the ochrea.

Sepals 3, connate below, linear-lanceolate to lanceolate-ovate, keeled, persistent, the two interior almost falcate.

Petals 3, united by their claws to form a hyaline tube ; lobes spreading. Corolla campanulate or funnel-shaped, soon caducous.

Stamens 6, all perfect, epipetalous : filaments subequal, filiform, contorted in bud, with heliotrope-coloured, moniliform hairs above the middle, fusiform beneath the acuminate tip, except in *C. cristata* and

C. pilosa : anthers basifixed, lobes parallel, oblong, dehiscing from the base along the outer edges : pollen orange-coloured.

Ovary sessile, hairy at the apex, 3-locular with two superposed ovules in each loculus, one erect and the other pendulous. Style linear, fusiform below the apex, naked or bearded. Stigma minute, terminal, punctiform.

Fruit enclosed in the dry cymes within the bracts and bracteoles and the persistent sepals, a very small, dry, oblong, chartaceous capsule, loculicidally 3-valved, usually 6-seeded ; valves loculicidally reflexed from the apex to the base, persistent ; placenta reflexed with the valves (in *C. tuberosa* var. *adscendens* the placenta remains as a central triquetrous column) ; walls brown, smooth, except at the hairy apex, with a well-marked transverse groove along the line of separation of the two seeds of each loculus.

Seeds angular, superposed : hilum almost punctiform, head to head, —if one ovule aborts the hilum is central : embryostega circular, umbonate, horizontal, apical in the upper and basal in the lower seed : testa firm, crustaceous, dark, rarely light coloured, sometimes obscurely vertically striated, on interior or both surfaces foveolate, rugose, or punctate. Embryo under the umbo, parallel to the axis of the capsule, vertical.

In all species, when favourable conditions prevail, vegetative propagation takes place. Except in *C. obtusa* Trim. and *C. tuberosa* var. *adscendens* Clarke, adventitious roots arise at the base of the leaf sheath and pierce it on the side opposite to the leaf. After flowers have been produced the axillary foliage bud grows through the base of the sheath on the same side as the leaf, the main stem dies off, and the branches develop into separate plants. Thus at each node vegetative propagation follows on sexual reproduction. In *C. obtusa* Trim. and *C. tuberosa* var. *adscendens* Clarke, vegetative propagation takes place similarly, except that the vegetative buds arise on the flowering shoots which thus serve as proliferating organs as well.

Key to the Ceylon species of Cyanotis

A. Fl. in scorpioid cymes with large imbricating bracteoles.
  1. Filaments fusiformly thickened below the tip.
    Style bearded.
      Root fibres slender
        Leaves 3-10 in. long, 0.75-1.5 in. broad, glabrous above, plant large — 2. *C. obtusa*
        Leaves 1-2 in. long, 0.2-0.3 in. broad, cobwebby, plant small — 6. *C. fasciculata*

Root fibres stout, ending in cylindrical tubers — 3. *C. tuberosa*

Style naked.

Stem trailing; leaves pubescent with short hairs, or if densely woolly equally pubescent on both surfaces — 4. *C. zeylanica*

Stem creeping below, then ascending; leaves densely woolly pubescent only on lower surface — 5. *C. villosa*

2. Filaments not fusiformly thickened below the tip.

Stem slender; leaves ovate-oblong, 1-3 in. long, 0.5 in. broad, sheath short — 1. *C. cristata*

Stem stout below; leaves linear, acuminate, 2.5-8.5 in. long, 0.17-0.33 in. broad, sheath broad — 7. *C. pilosa*

B. Fl. fascicled, bracteoles concealed in the leaf sheath. — 8. *C. axillaris*

1. **C. cristata** Schultes *f.*, Syst., VII, 1150 (1830); Thw. Enum., 323; Clarke, Mon., 247; Fl. Brit. Ind., VI, 385; Trimen, Fl. Ceylon, IV, 311. Herm., Mus., 53. Burm., Thes., 94. Fl. Zeyl., No. 32. *Commelina cristata* Linn. Sp. Pl., 62. *Tradescantia cristata* Willd., Moon, Cat., 24. Bolhinda, S.

Stem much branched, branches decumbent, lower part purple, upper green: internodes 1-4 in. long, cylindrical, sparsely hirsute or densely and shortly pubescent along a single line reaching from the fused edges of the leaf sheath to the node above. Leaves ovate-lanceolate: sheath 0.5 in. long, green, with distinct purple venation, sparsely hirsute: blade 1.5-3 in. long, 0.4-0.8 in. broad, smooth, hirsute at the colourless margins. Cyme 0.5-0.75 in. long. Bract 2 in. long, 0.6 in. broad, ovate-lanceolate to ovate-cordate, base broadly cordate, amplexicaul, apex acute, colourless, margins colourless, hirsute only towards the apex. Flowers sessile. Sepals linear-lanceolate in outline, acute, boat-shaped and distinctly keeled; margins membranous. Corolla funnel-shaped, lobes semicircular with an acute apex and sinuate margins, light heliotrope. *Filaments not fusiformly thickened.* Style naked, fusiformly thickened at the apex.

Low country; a common weed. Fl. April; heliotrope.

2. **C. obtusa** Trimen, Fl. Ceylon, IV. 312. *C. arachnoidea* var, *obtusa* Trimen, in Journ. Bot., XXIII, 266, and Syst. Cat., 95. *C. arachnoidea Clarke* (in part) Fl. Brit. Ind., VI, 386.

3. **C. tuberosa** Schultes *f.*, Syst., VII, 1153 (1830) var. *adscendens* Clarke, Mon., 249 ; Trimen, in Journ. Bot., XXIII. 173, Syst. Cat., 95, and Fl. Ceylon, IV. 312. Golubellawel, S.

Root fibres stout, ending in cylindrical, fusiform, tubers about 2 in. long, 0.25 in. diameter: about a dozen such tubers to a shoot. Stem differentiated into a foliage shoot and a flowering shoot. Stem of foliage shoot about 1 in. long, enclosed within the sheaths of the leaves. Leaves 8-9 in. long, 0.45 in. at broadest, linear, boat-shaped without a distinct keel, fleshy, stiff, glabrous on the upper surface, hirsute with distinct venation on the lower : margins colourless, ciliate : apex acute : leaf sheaths 0.5-1 in. long, edges fused, dried, brown, the membranous remains enclosing the stem. Flowering shoots 2 or more from the axil of a leaf on a barren shoot, 1-1.5 ft. long, trailing, cylindrical, hirsute, swollen and jointed at the nodes, terminating in a cyme. Leaves of the flowering shoot 1 in. long, 0.25 in. broad, sheath 0.5 in. long, solitary at the nodes. Adventitious roots and one or more foliage shoots arise from the nodes of the flowering shoot. Here the flowering shoots serve also as proliferating organs. Cyme 1.5 in. or more long, curling downwards, resembling a small snail (hence its Sinhalese name), pubescent. Bracts lanceolate, acute, entire, partly sheathing, the upper surface glabrous, the lower hirsute. Bracteoles falcate. Sepals linear-lanceolate, acute, the inner surface glabrous, the outer densely woolly pubescent. Corolla light heliotrope ; lobes broadly ovate, acute. Filaments fusiform. Style fusiform, *bearded.* Ovary densely pubescent.

Damp sandy ground in the dry region ; very rare. Only found at Kirinde, S. Province. Fl. Dec., heliotrope, *not blue.*

Hooker *f.* has the following note in Trimen, Fl. Ceylon, IV, 313, " a most variable plant in habit, foliage, and pubescence. The Ceylon specimens are very poor, much smaller than the Peninsular (from which the description [in Trimen, Fl. Ceyl.] is chiefly taken), and more glabrous, with smaller, nearly sessile cymes. I have not seen the style of the Ceylon specimens. J.D.H." The description given above is from fresh specimens collected at Kirinde in December 1922.

4. **C. zeylanica** Hassk., Comm. Ind., 145 (1870); Clarke, Mon., 252 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 313. *C. lanceolata* var. *subglabra* Thw., Enum., 323; C.P. 3223, 3216.

Stem cylindrical, trailing, reaching several yards in length : internodes 0·5-3 in. long, deep purple, covered with short glandular hairs. Leaves ovate, 1-2 in. long, 0·5-0·8 in. broad, acute, shortly ciliate towards the margins ; sheath 0·2-0·5 in., strongly hirsute, paler than the blade, with distinct purple veins. Cymes hirsute. Bract 1 in. long, 0·6 in. at widest, lanceolate, base rounded, shortly sheathing, glabrous, acute, margins hirsute. Bracteoles falcate, glabrous, acute. Flower shortly pedicelled. Sepals lanceolate. Corolla lobes broadly ovate, acute. *Filaments fusiform.* Style fusiform, naked.

Montane zone 4-6000 ft., rather common. Fl. Oct-Jan.; purple. Endemic.

5. **C. villosa** Schultes *f.*, Syst., VII, 1155 (1830) ; Clarke, Mon., 251 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 313. *C. lanceolata* Wight, Thw. Enum., 323 in part. C.P. 2332.

Stem stout, cylindrical, creeping below, then ascending, reaching a length of several feet : nodes swollen : internodes about 1 in., purplish red, sparsely covered with long hairs ; from the overlapping edges of the sheathing base of the leaf above to the axil of the leaf below is a line along which the hairs are denser ; some internodes uniformly woolly pubescent. Leaves 1-3·25 in. long, 0·6 in. broad, fleshy, ovate to linear-lanceolate, acute or acuminate, entire ; upper surface glabrous and shining, lower woolly pubescent, green to purplish red ; veins distinct on the lower surface ; sheath usually more densely pubescent than any other part of the plant. Cyme woolly pubescent. Bract very much like a reduced leaf, about three times as long as the cyme. Bracteoles semi-ovate to semi-circular. Flower sessile. Sepals lanceolate-ovate, deeply keeled, glabrous except at the hirsute apex and the margins and keel. Corolla campanulate ; lobes semi-circular, acute. *Filaments fusiformly thickened,* curled like tendrils. Style fusiformly thickened, naked, curled.

Moist region 2-5000 ft.; rather common. Fl. Sept., Oct.

6. **C. fasciculata** Schultes *f.*, Syst., VII, 1152 (1830) ; Thw. Enum., 323 ; C.P. 2433 (*fide* Clarke) ; Clarke, Mon., 253 ; Fl. Brit. Ind.,VI, 387 ; Trimen, Fl. Ceylon, IV, 314.

Stem differentiated into foliage shoots and flowering shoots, floccosely silky or cobwebby. Foliage shoots decumbent and profusely branched, forming groups reaching about 1·5 ft. in length ; internode 0·75-1 in. long, wholly or partly enclosed within the leaf-sheath. Leaf linear, somewhat curved and fleshy, 3 in. long, 0·6 in. at broadest, lower surface paler, upper grooved along the middle, tapering, subapi-

culate, arachnoid. Flowering shoot 3·5-11 in. long, simple or branched, cylindrical, fleshy, arising from the ascending parts of the main stem : roots at nodes only if separated from the rest of the plant ; internodes 1-3 in., cottony pubescent. Leaves of the flowering shoot smaller than, but similar in appearance to, the leaves of the barren shoot. Flowering stalk in the axil of a leaf of the flowering shoot, bearing only a single lateral branch in the axil of a membranous leaf. Cymes shortly stalked, flat, urn-shaped, with or without cottony pubescence. Bracts lanceolate, acute, base plicate, woolly pubescent. Bracteoles falcate, acute, woolly pubescent. Flower almost sessile. Sepals lanceolate, acuminate, outer surface woolly pubescent. Corolla funnel-shaped, lobes broadly spathulate, acute. *Filaments fusiformly thickened. Style bearded* and fusiformly thickened.

Exposed rocky ground in the wet and the dry zones, up to 4,000 ft.; common. Fl. March, Oct.; bright violet blue.

7. **C. pilosa** Schultes *f.*, Syst., VII, 1155 (1830), *non* Wight ; Thw. Enum., 323 ; C.P. 2332 ; Clarke, Mon., 251 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 314.

8. **C. axillaris** Schultes *f.*, Syst., VII, 1154 (1830) ; Thw. Enum , 323 ; C.P. 2330 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 315. *Tradescantia axillaris* L., Moon, Cat., 24.

Stem slender, trailing, reaching about 2 ft. in length. Leaves few, linear, entire, sub-apiculate, glabrous. Several flowers arise in the axil of the same leaf. Flowers ochreate, pedunculate, pale violet-blue. Sepals lanceolate, keeled. Corolla lobes obcordate. Filaments fusiformly thickened. *Style naked,* fusiformly thickened.

Low country in both regions ; common. Fl. March, October.

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Sansevieria zeylanica Willd.

BY

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Brown, in his monograph of the genus *Sansevieria*, (2), p. 227, stated that he had not seen flowers of *S. zeylanica* Willd., and added, " It is remarkable that, although this species was one of the earliest to be described, yet it is one of the least known, or rather is practically an unknown plant to science, since in all modern descriptions, it is inextricably mixed up with the Indian *S. Roxburghiana* and *S. lanuginosa*, and the South African *S. aethiopica*. The confusion was begun by Willdenow himself, who mixed up two other species with this." He also remarked, " I think the specific name *zeylanica* should be exclusively applied to the Ceylon plant, which, with the exception of the living plants now at Kew.....does not appear to be anywhere in cultivation out of Ceylon, nor have I seen in any British or foreign Herbarium good dried specimens that I should unhesitatingly refer to the true Ceylonese plant.....in no single instance have I seen a localised dried specimen from Ceylon."

In the Peradeniya Herbarium there are two sheets labelled *S. zeylanica*. One, from a Kurunegala garden, has no flowers ; it bears the C.P. number 2297 and is probably from Thwaites' collection. The other, also without flowers, was collected by Trimen in January 1888 near Nilgala. Hooker *fil.*, (1) who amplified Trimen's manuscript notes, gives a description of *S. zeylanica*. These notes have been preserved with the Herbarium sheets, and in them Trimen records a description of a Ceylon *Sansevieria*, grown in the Royal Botanic Gardens, Peradeniya, and refers to " a good woodcut " of the plant in the Kew Bulletin of 1887. Brown (2) says that the latter is a figure of *S. Roxburghiana*. Hooker's (1) description is thus very probably of *S. Roxburghiana* and not of *S. zeylanica*, a confusion which might have arisen from an interchange of the labels in the Peradeniya Gardens. The late Mr. van Buuren, at whose suggestion this work was undertaken, told me that plants of *Sansevieria*, obtained from the jungle and transplanted in the Peradeniya Gardens, did not flower even once during the five years he had them under observation. That has been my experience

too, with similar specimens grown in the gardens for the past two years. These observations tend to confirm the suspicion that Trimen's description is that of *S. Roxburghiana*.

The description of *S. zeylanica* Willd. given below is from specimens obtained in the jungle at the foot of Doluwe Kande and from the Anuradhapura district.

Sansevieria zeylanica Willd. Sp. Pl., 11, 159 (1799); Moon, Cat., 25; Thw., Enum., 338. Herm., Mus., 56. Burm., Thes., 11. Fl. Zeyl., n. 130. Niyanda, S. Maral, T.

Stemless. Rootstock creeping, stoloniferous, yellowish white, several feet long. Plants twenty to thirty in a single clump. Leaves 5-12 to a growth, recurved from a little above the middle, erect or ascending; the outer about 2·5 ft. long, 1·3 in. wide at broadest, lanceolate, more or less flat: the inner longer and thicker than the outer: all leaves subapiculate, ending in a sharp brown spine, 0·2-1 in. long, colourless and sheathing at the base for a length of 1-3 in.; both surfaces slightly shining, gland-dotted, and smooth, the lower less so; all leaves with transverse bands of light and dark green merging one into another; margins membranous, colourless or green, turning brownish-red as the leaf ages; the inner leaves in transverse section concave-channelled and very nearly semi-terete; *all leaves longitudinally furrowed on the back*.

Brown (2), p. 226, described the furrows as occurring only on withered leaves of *S. zeylanica*, and used this as a specific difference to distinguish between *S. zeylanica* and *S. lanuginosa* (p. 193).

Inflorescence a scape 13·5-23 in. high, arising from the centre of the plant within the leaves. Scape terete, fleshy, colourless for about 2 in. from the base, then green with reddish green spots: young scapes purple. At distances of 4 and 6·25 in. respectively, are two submembranous sheaths, the lower 0·75-1·6 in. long, and the upper 0·4-0·5 in. long; both sheaths green and glabrous with distinct venation, margins membranous, tapering to a minute, subulate, dark green spine.

Flowers on a minute swelling, in suberect fascicles of 6, which are distant from one another at the lower end, becoming more crowded towards the tapering apex of the scape. The lowest fascicle 7·5 in. from the base. Each fascicle in the axil of a membranous, linear, acuminate bract about 0·5 in. long. Each flower in the axil of a minute, scale-like, ovate, acute bractlet.

Pedicel of each flower about 0·25 in. long, fleshy, jointed near the base; the lower part purple, the upper green. The flower is often deciduous about this joint.

Flower about 0·6-0·9 in. long, 0·2-0·5 in. across, pale greenish-white, somewhat scented.

Perianth lobes 6, united along a third of their length. Each lobe 0·6 in. long, oblong, linear, white with a greenish-white to purple, rounded, boat-shaped, curled apex : base yellow-green.

Stamens 6, epipetalous and opposite the perianth lobes ; filaments tapering ; anthers versatile, sagittate, yellowish-green.

Ovary 0·1 in. long, trilocular, trigonous, smooth, glabrous, with a single basifixed ovule in each loculus ; style about 0·8 in. long, fleshy ; stigma triangular.

Fruit a globose berry, 0·4-0·6 in. in diameter, on a jointed stalk. Only one or two of the ovules are fertilised, and the fruit is either single or bi-lobed accordingly, the sterile loculi persisting as minute swellings at the base of the berry.

Seed creamy-white, broadly ovoid, horny, about 0·25 in. long, with a large yellow patch on the exterior ; embryo small, marginal.

Common in rocky or sandy places in the dry region.

Brown (2), p. 228, says that *S. Roxburghiana* can easily be distinguished from *S. zeylanica*, "for its leaves are mostly shorter, much thinner and consequently less rigid than those of *S. zeylanica*, also of a rather lighter and different tint of green." *S. Roxburghiana* also differs from *S. zeylanica* in that, 1, leaves of the former have green edges which change to white as the leaf ages whereas those of the latter turn to a brownish-red ; 2, the scape of the former has four to five membranous sheaths while that of the latter has only two membranous sheaths ; 3, the flowers of the former arise in groups of about four and of the latter in groups of six.

REFERENCES.

1. Hooker, J. D. in Trimen, Flora of Ceylon, IV (1898), p. 267.
2. Brown, N. E. Monograph of the genus *Sansevieria*. Kew Bulletin, 1915, No. 5, pp. 185-261.

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Plaesianthera

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In Flora British India, Clarke (2), after his description of *Cardanthera Thwaitesii* Benth., wrote, " Possibly a distinct genus resembling *Brillantaisia* except that it is the posterior stamens that are imperfect in this." Trimen (3) stated of the same plant, " Forms a very distinct sub-genus, *Plaesianthera*, Clarke, which ought rather to be considered distinct from *Cardanthera*."

Bentham and Hooker f. (1) gave, among the other characters of the genus *Cardanthera* Hamilt.,

1. Flores ad axillas sessiles v. breviter pedicellati, *solitarii v. plures*, 2-*bracteolati*, v. rarius cymae axillares laxi florae.
2. Calyx 5-partitus, segmentis angustis subaequalibus v. postico majore.
3. Corollae limbus *longe* 2-*labiatus* antico erecto-patente apice 3-lobo infra lobos *saepius* 2-*plicata*.
4. Stamina perfecta 4, *didynama*, *v.* 2 *antica*.
5. Filamentis basi breviter dilatatis.
6. Antherae *oblongae loculis parallelis*.

This enumeration of the generic characters of *Cardanthera* was based upon ten species, including *C. Thwaitesii* Benth., which differs from the other nine as shewn in the table given below.

C. Thwaitesii Benth.	Other *Cardanthera* spp.
1. Flowers solitary in alternate axils.	Flowers spiked or whorled in opposite axils.
2. Bracteoles none.	Bracteoles 2.
3. Calyx 5-partite, segments unequal.	Calyx 5-partite, only the posterior segment larger.
4. Corolla shortly 2-lipped.	Corolla deeply 2-lipped.
5. Corolla palate plane.	Corolla palate transversely plicate-rugose.
6. Stamens 2 ; staminodes 2.	Stamens 4 perfect.
7. Filaments uniform, tapering to the narrow apex.	Filaments dilated at base.

8. Anther lobes subquadrate, united to form an almost horse-shoe shaped anther.	Anthers oblong, lobes parallel.
9. Seeds with slightly curved, strong retinacula.	Seeds with minute, straight retinacula.

In view of these differences, *C. Thwaitesii* should be placed in a genus distinct from *Cardanthera*. Clarke's sub-genus *Plaesianthera* should therefore be given generic rank.

Plaesianthera (Clarke), nov. gen. Acanthacearum.

Herba erecta. Folia opposita. Bracteola nulla. Flores solitarii. Calyx 5-partitus, segmentis inaequalibus. Corollae tubus superne ampliatus; limbus breviter 2-labiatus, labio postico erecto concavo breviter 2-lobo, antico erecto patente apice 3-lobo. Stamina 2, antica, supra medium tubum affixa; filamenta non basin dilatata; antherae subquadratae, loculis non parallelis. Stylus apice linearis; ovulae in loculis numerosae. Capsula oblongo-linearis. Semina parva, ovata compressa, in retinaculis dilatatis fulta. Monotypic and endemic Genus.

Plaesianthera Thwaitesii (Benth.) Livera, comb. nov.; *Adenosma Thwaitesii* T. And.; *Cardanthera Thwaitesii* Benth., Gen. Pl., II, (1876), 1075.

Caulis erectus, viscidulus, villosus, racemosus; folia integra, spathulata v. lanceolata, subpetiolata, hirsuta, subtus glabrescentia; flores solitarii in cymis laxis; bractea parva. Calyce capsula dimidio brevior.

Roots fibrous, adventitious, the main root being short in most specimens. Stem herbaceous, 4-12 in., erect, pyramidally much branched, terete below, quadrangular above, densely glandular hairy. Leaves numerous, opposite; on the main stem 1-1.5 in., lanceolate or spathulate; on the branches 0·25-0·75 in., oval; all obtuse or subacute, faintly crenate, almost entire, tapering to the short petiole, hirsute, paler beneath. Inflorescence a dichasial cyme, becoming sympodial, the upper branches having one branch and one flower suppressed. Pedicel 0·2-0·3 in. long. Bracts like very reduced leaves. Bracteoles 0, calyx 5-partite, lobes linear, unequal, outer surface glandular hairy. Corolla 2-lobed, lobes twisted to left, not transversely plicate. Stamens 2, epipetalous; anthers introrse, lobes subquadrate, fused at the apex, forming an almost horse-shoe-shaped structure but with the apex more acute. Ovary glabrous. Style sparsely hairy. Capsule 0·25 in.; seeds many, ovoid, compressed; retinacula conical, slightly curved.

Dry region, rare; Batticaloa District, abundant; Karamunai. Fl. March.

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The Jussiaeas of Ceylon

BY

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In his article of the Indo-Malayan species of *Jussiaea*, Ridley (1) mentions Ceylon as the habitat of only *J. erecta* var. *exaltata* Roxb. and *J. speciosa* Ridl. In the Peradeniya herbarium there are sheets of *J. erecta* L., *J. erecta* var. *exaltata* Roxb., *J. villosa* Lam., and *J. speciosa* Ridl. The descriptions given below are from the Ceylon specimens.

Key to the Ceylon Species of Jussiaea.

Stem creeping or floating. 1. *J. repens* L.

Stem erect.

Plant nearly glabrous ; fruit narrow cylindric 2. *J. erecta* L.

Plant hairy

Corolla 0·8 in. across ; sepals ovate, acute ; fruit thickly cylindric ; seeds grooved 3. *J. villosa* Lam.

Corolla 2 in. across ; sepals triangular, acuminate, cuspidate ; fruit obconic ; seeds not grooved. 4. *J. speciosa* Ridl.

1. **J. repens** L., Sp. Pl., 388 (1753) ; Fl. Zeyl., n. 169 ; Moon, Cat., 35 ; Thw. Enum., 123 ; C.P. 2793 ; Fl. B. Ind., II, 587 ; Hook. Bot. Misc., III. t. Supp. 40 ; Trimen, Fl. Ceylon, II, 233. Beru-diyanilla S.

2. **J. erecta** L., Fl. Zeyl., 170 ; Sp. Pl., 556 (excluding the S. American plants) ; *J. angustifolia* Lam.; *J. Blumeana* DC.; *J. Junghuhnii* Miq.; *J. suffruticosa* of Clarke and other botanists, not of Linnaeus ; *J. villosa* var. *subglabra* Thw., Enum., 123.; C.P. 1540; *J. suffruticosa* var. *subglabra* (Thw.) Trimen, Fl. Ceylon, II, 233.

Herb 1-1.5 ft. tall, glabrous, or sparsely hairy specially on the young parts. Stem woody at base, slightly winged above, once branched. Leaves 1-4 in. long, 0·2-0·9 in. broad, lanceolate, acute, tapering at base, subsessile, sparsely hairy ; veins ascending, about 16 pairs, slightly elevated beneath. Pedicel 0·05-0·1 in. Sepals 4, ovate, 0·2-0·25 in. long,

acuminate, 3-veined, hairy. Corolla 0·75 in. across ; petals obovate, emarginate, clawed, distinctly veined. Stamens 8. Ovary 0·3-0·4 in. long. Style short and thick. Fruit 1-1·5 in. long, 0·2 in. across at top, oblong, obcuneate, glabrous, broadest above, narrowed at base. Seeds ellipsoid, polished, mahogany brown.

Var B., **exaltata** Roxb. Leaves linear, with more numerous, short hairs on both surfaces.

Distribution. Wet places in moist low-country to 3000 ft.; common. Fl. Feby. Var. B, Bandarawela, Sept.

Ridley (3) does not mention the last two synonyms ; perhaps he did not see the Ceylon specimens of *J. erecta* L.

3. **J. villosa** Lam., Encycl., III, 331 ; C.P. 3297, 2794. A tall, woody, densely hairy shrub. Leaves 1·7-3·7 in. long, 0·35-1·1 in. broad, lanceolate, narrowed at both ends, shortly petiolate or sessile, hairy all over. Sepals 0·3 in. long, 0·15 in. wide at base, ovate, acute, hairy outside. Corolla 0·8 in. across ; petals oblong oblanceolate, retuse, 0·3 in. across. Ovary cylindric, hairy, 0·4-0·6 in. long. Fruit 1-1·25 in. long, 0·25-0·5 in. across, stoutly cylindric, base narrowed. Seeds dark red, ellipsoid, grooved.

Distribution. Near Galle ; Kandy. Fl. Sept., Oct.

4. **J. speciosa** Ridley, Journ. Bot., 1921, p. 259. Plant 3-4 ft. tall, densely softly tomentose-hairy all over. Leaves 2·5-3·5 in. long, 1 in. broad, lanceolate, narrowed at both ends ; petiole 0·25 in. long. Flowers 2 in. across, solitary, axillary. Pedicel 0·45 in. long, quadrangular, pubescent. Bractlets 2, lanceolate, acute, 0·4 in. long. Sepals 4, 0·55 in. long, 0·27 in. broad, triangular, acuminate, cuspidate, densely hairy on outer surface. Petals 0·8 in. long, 1 in. broad, obovate, retuse, distinctly 15-veined, shortly stalked. Stamens 8 ; filaments twisted in a counter-clockwise direction. Anthers extrorse. Stigma viscid, dome-shaped ; ovary 0·6 in. long, pyramidal. Capsule obconic, densely softly hairy. Seeds ellipsoid, not grooved, red.

Distribution. Haragama ; Maturata ; Peradeniya. Fl. Jan-June; bright yellow.

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Ceylon Pink-spored Agarics.

BY

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The majority of Berkeley and Broome's species of *Rhodosporae* have not been recognised during the last eighteen years, and consequently re-description has not been possible. Notes on these, from the herbarium specimens and paintings, are included below. Measurements of the spores, and details regarding the presence or absence of cystidia in the herbarium specimens, have previously been published by Massee (Grevillea, XXI, pp. 77-82). Massee found that cystidia were wanting in most of the Ceylon species, and in general it has been possible to confirm his statement, as far as regards the herbarium specimens. But in this respect the herbarium species are apt to be misleading. In some cases, cystidia are well-preserved on the dried specimens, but in a recent examination of specimens collected during the last ten years I have failed, after repeated attempts, to find cystidia on some herbarium specimens on which cystidia were seen, measured, and described when fresh. Consequently it is not possible to decide that a species lacks cystidia, from failure to find them on a herbarium specimen.

VOLVARIA

Berkeley and Broome enumerated nine species of *Volvaria* in the Fungi of Ceylon. Coloured figures of two of these, *Volvaria terastia* B. & Br. and *Volvaria diplasia* B. & Br., were reproduced in Trans. Linn. Soc., XXVII, plates 33, 34, and there are paintings of four other species in Herb. Peradeniya. One species, *Volvaria Geaster* B. & Br. is a partly-expanded specimen of *Amanita vaginata*. One European species, *Volvaria volvacea* Bull., was recorded, and of the remainder two are generally large species, three are of medium size, and two are very small. Thwaites's collection numbers are somewhat confusing. *Volvaria diplasia* and *Volvaria terastia* were sent as 689 and 689 bis, while other collections were sent together in various combinations of the numbers 709, 777, and 790. Thwaites had apparently regarded the last three collections as the same species, and in Herb. Peradeniya the specimens of these three numbers are mounted on one sheet.

Volvaria terastia B. & Br. was re-described in Ann. Perad., IV, p. 40. The pileus attains a diameter of 20 cm., and is blackish brown, dark purple brown, grey, or brownish grey, densely clothed with radial adpressed silky fibrils. The stalk is white or grey, and up to 15 cm. high. The volva is usually large and stout, and black or blackish brown externally; internally it may be marked with distant yellow-brown patches. When the fungus expands, the surface of the volva usually splits into more or less rectangular areolae, separated by white bands. The spores are deep Indian red in mass, brownish by transmitted light, thick-walled, subglobose, 3·5-6 μ, or broadly oval, 5-6 × 4-5 μ, sometimes somewhat pyriform, with a prominent apiculus; the thick wall is penetrated nearly to the exterior by a narrow canal beneath the apiculus. Massee, Grevillea, XXI, pp. 77-82, gave the dimensions of the spores as 4 μ, or 4 × 3 μ. It grows on the ground.

In one example, the unopened volva had a shining, yellow-brown surface, which split into areolae bordered by sloping sides of grey hyphae.

Volvaria diplasia B. & Br. This species was re-described in Ann. Perad., IV, p. 51. It is usually smaller than *Volvaria terastia*. In the typical form the pileus is pale yellow or greyish white, up to 11 cm. diameter, densely clothed with fascicles of short silky hairs. The stalk is white, strongly attenuated upwards and more or less conical. The volva is thin, lax, usually sheathing the stem, tough, white or pale-brown and smooth externally, white with scattered yellow spots internally. The spores are deep Indian red in mass, but not markedly coloured when examined by transmitted light; they are oval, sometimes inequilateral, 7-10 × 4-5 μ. The edge of the gills bears oval cystidia, 50 × 28-30 μ, sometimes attenuated above and broadly flask-shaped.

This species grows on decaying stumps or wood, or on dead leaves matted together by mycelium. The form described by Berkeley and Broome is greyish white, but the colour is variable. In one example, partly hidden by a decaying log, the exposed half of the pileus was golden yellow and the shaded side pure white. Some specimens are blackish, and closely resemble *Volvaria terastia*, and the surface may split into radial anastomosing lines of blackish-brown silky fibrils.

Berkeley and Broome cited Thwaites 689 as *Volvaria diplasia* and 689 bis as *Volvaria terastia*. The spores of Thwaites 689 in Herb. Kew are oval, sometimes inequilateral, 7-10 × 4-5 μ, while those of the same Thwaites number in Herb. Peradeniya are 6-9 × 4-6μ The Kew specimen shows cystidia on the gill edge. Thwaites 689 bis in Herb. Peradeniya is immature as to one specimen, while the other has

spores, globose, 3·5-6 μ, or broadly oval, 5-6 × 4-5 μ, identical with those described above for *Volvaria terastia*.

Volvaria volvacea Bull. This was recorded for Ceylon by Berkeley and Broome from Thwaites 790. The specimens in Herb. Kew have the pileus radially streaked with black lines, and in one the volva is feebly areolated. The spores are oval, 7-9 × 4-5 μ. There is a corresponding specimen, but small, on the sheet marked 777, 709, 790, in Herb. Peradeniya. These specimens are *Volvaria diplasia*.

Volvaria pseudovolvacea B. & Br. This was described by Berkeley and Broome from Thwaites 709, 777, 790, in part. They also described *Volvaria apalotricha* B. & Br. from Thwaites 709, *cum icone*, and *Volvaria coleata* B. & Br. from Thwaites 709.* *cum icone*. There are three figures in Herb. Peradeniya, one marked "709, a small form of 790", another, "709, 20 August. 1868," and a third, "Pileus delicately pilose, No. 709,* 15th August, 1868." The figures appear to be all the same species.

In Herb. Peradeniya, there is one sheet, marked 709, 777, 790, bearing specimens which vary from 3 mm. to 5 cm. in diameter. One specimen is *Volvaria diplasia*, as noted above. The larger specimens have spores 5 × 3 μ. The very small specimens have smaller spores, 3·5-5 × 3 μ.

In Herb. Kew, *sub Volvaria pseudovolvacea*, there are three sheets. One is marked by Thwaites "Nos. 709, 777, 790, Peradeniya, December. 1868-Jan. 1869, sent before, but I fear with other species admixed. This differs from those in having a volva and a pileus striato-ciliate;" the spores of these are oval, inequilateral, 4-6 × 3-4 μ, or globose, 3-4 μ. Another is marked "709 and 790, intermediate between the specimens sent you under these numbers, Peradeniya, Nov. 1868;" the spores of these are oval, 4-6 × 3-4 μ. The third sheet, No. 777, bears specimens with spores 7-10 × 4-5 μ, which are *Volvaria diplasia*.

For *Volvaria apalotricha* B. & Br., Berkeley and Broome cited Thwaites 709, *cum icone*. The specimen in Herb. Kew is marked by Thwaites, "709 (small form of No. 790), Peradeniya, Nov. 1868, see drawing." It has narrow gills, a small strict volva, and a pileus strongly radially black-fibrillose; its spores are 5-6 × 3·5-4 μ. Massee (*loc. cit.*) gave the dimensions of the spores, 3 × 2 μ.

Volvaria coleatus B. & Br. was Thwaites 709*, *cum icone*. The specimen is marked by Thwaites 709, without asterisk. The gills are narrow and the volva small; and the pileus is radially streaked with black fibrils, which tend to become free at the ends. The spores are 5 × 3 μ, not 3 × 2 μ as given by Massee.

All these three appear to be the same species. Berkeley and Broome stated that *Volvaria coleata* was closely allied to *Volvaria apalotricha* but differed in several important particulars. They did not, however, state what those particulars were.

Volvaria pseudovolvacea B. & Br. Pileus broadly convex, up to 5 cm. diameter, closely streaked with radial black-brown lines, white or greyish between ; flesh thin, white ; stalk up to 9 cm. high, 3 mm. diameter, white, slightly attenuated upwards, powdered, stuffed, almost solid ; gills narrow, equal, not crowded, margin entire ; volva usually small, thin, sheathing the stem, brownish white ; spores oval, inequilateral, 4-6 × 3-4 μ, or globose, 3-4 μ diameter. On the ground among dead leaves, or on wood.

The figures of *Volvaria apalotricha* and *Volvaria coleata* show specimens with pilei 2-3 cm. diameter, the total height of the fungus being 3·5-5 cms.

Volvaria microcoelia B. & Br. Berkeley and Broome separated this from Thwaites 709. There is no specimen in Herb. Peradeniya, and it has not been recognised again. The specimen in Herb. Kew has a pileus 12 mm. diameter, and a stalk 2·2 cm. high ; the stalk is thin and the volva small. It differs from the other species of *Volvaria* known from Ceylon in its spherical spores, 4-5 μ diameter.

According to Berkeley and Broome, the pileus is livid, clothed with scattered hairs, campanulate becoming plane, 1·2 cm. diameter ; stalk slender, 2·5 cm. high, 1 mm. diameter ; gills narrow, ventricose ; volva dark. As there was no painting of this species, the description of the colour must have been deduced from the dried specimen.

Volvaria glandiformis B. & Br. Pileus campanulate, then plane, 1·5 cm. diameter, centre umbonate, sulcato-striate up to the umbo, which is surrounded by a depressed ring, white, with a faint pink tinge, greyish in the centre, covered with long, silky, closely adpressed hairs ; stem 1·7 cm. high, 1·5 mm. diameter, equal, or expanding upwards, white, striate, solid ; gills pink, distant, thick, variously forked, equal, 1·5 mm. broad, rounded at each end ; volva somewhat bilobed, spreading, 4 mm. high, grey and silky externally; spores elliptic, 6-10 × 3·5-5μ. On the ground or on dead wood.

Berkeley and Broome described the pileus from the figure as ovate, estriate. The figure shows an unexpanded example, but the dried specimens are sections of two, one partly and one fully expanded, and in the latter the pileus is plicato-sulcate. The spores on the herbarium specimens are 5-8 × 3·5-4·5 μ ; those on recent examples, from which the

above description has been drawn up, were 8-10 × 4-5 μ. The recent specimens grew on the ground; Thwaites's painting appears to show a specimen growing on wood.

PLUTEUS

Berkeley and Broome enumerated twenty-one species of *Pluteus* in the Fungi of Ceylon, all, as far as information is available, being collected at Peradeniya or in the close vicinity. In Thwaites's time, the Botanic Gardens were maintained in a "natural" condition, fallen trees being left to decay. Consequently, it is probable that, at that period, *Plutei*, and other agarics which grow on wood, were more abundant at Peradeniya than they are now. At the present day, *Plutei* are comparatively scarce, except for three species,—*Pluteus spilopus* B. & Br. which is frequent round decaying stumps; *Pluteus glyphidatus* B. & Br., fairly common on decaying palm fronds in dense shade; and *Pluteus stigmatophorus*, which springs up occasionally round decaying stumps in flower pots at the Laboratory.

Pluteus spilopus B. & Br. Pileus up to 10 cm. diameter, almost plane, slightly obtusely umbonate, blackish brown, with darker radial streaks, minutely squarrose in the centre, elsewhere innately radially silky when dry, the cuticle becoming somewhat subgelatinous in very wet weather; flesh white, moderately thick. Stalk up to 10·5 cm. high, usually attenuated upwards, up to 1·5 cm. diameter at the base, and 1 cm. at the apex, but more or less equal in dwarf specimens, solid, brittle, longitudinally striate, covered with black fibrils and minute black-brown particles in clusters. Gills free, ventricose, rounded behind, rather distant: cystidia on the edge of the gills, flask-shaped, up to 48 μ high, 26 μ diameter below, 8μ diameter above, or fusiform, up to 72 μ high, 26 μ diameter, or clavate, 40-50 × 16 μ. Spores globose, 5-7 μ, or broadly oval, 5-9 × 4-7 μ, smooth.

This species grows in numbers round decaying stumps, *i.e.* on the ground, not on the wood. It also occurs singly on lawns, probably from buried wood. Examples which appear during the rains are up to 11 cm. high, and the cuticle tends to become subgelatinous and to separate in flakes. Those which spring up in drier weather are only about half that height, and the surface of the pileus is dry and innately silky or fibrillose. Berkeley and Broome referred the wet weather form to *Pluteus cervinus*, while they described the drier weather form as *Pluteus spilopus*. It appears to be distinct from *Pluteus cervinus* in the squarrose centre of its pileus and the black points and fibrils on the stalk.

Pluteus spilopus is on record as a British species If, however, the British examples are correctly represented by Plate 325 of Cooke's Illustrations, there would not appear to be any doubt that they are not *Pluteus spilopus*. The two upper figures of the plate in question are marked M.J.B.,and they are apparently intended to be copies of Berkeley's figures of the Ceylon *Pluteus spilopus*. Thwaites sent paintings of the Ceylon agarics, and Berkeley had copies of these made which are now in the Library of the Kew Herbarium. Cooke appears to have copied the figures of *Pluteus spilopus* from Berkeley's copies, but they have been decidedly modified in the process.

The original painting evidently represents a distorted example. The pileus is bilobed, and the two halves are bent down on either side of the stalk, so that the painting of the whole fungus shows not only the upper surface of one half of the pileus, but also part of the lower surface of the other half. The furrow round the obtuse umbo, which was taken to be one of the distinguishing characters of the species, is no doubt attributable to the distortion of the pileus ; it does not occur in recent examples. There is no indication of any wood on the figures ; the specimens apparently grew on the ground. The colour of the pileus is very dark, the radial streaks being almost black. Cooke's reproduction omits the reverse view of the hinder half of the pileus, adds a piece of wood to the base of the stalk, and changes the colour completely.

Pluteus glyphidatus B. & Br. Pileus campanulate, obtuse, then expanded, umbonate, up to 5 cm. diameter, lemon yellow, covered with minute, ashy, or grey, close-set warts or points, or streaked with ashy fibrils, the centre remaining yellow, elsewhere becoming pinkish, margin striate; flesh thin, white. Stalk up to 6 cm. high, 4 mm. diameter, pale yellow or white, equal or slightly attenuated upwards, glabrous, powdered, tomentose at the base, solid. Gills yellowish, then pink, free, distant, broadly ventricose or equal, rounded at both ends, margin serrate ; cystidia on the gill edge in tufts up to 150 μ high, individual cystidia cylindric, flask-shaped, or broadly conoid, up to 150 μ high, 40 μ diameter, those on the face of the gills scattered, cylindric, slightly attenuated above, or broadly oval, 50 μ high, 30 μ diameter. Spores Indian red in mass, globose, 5-7 μ diameter, or broadly oval, 5-6 × 4 μ.

Common on decaying palm fronds on rubbish heaps in the shade, Peradeniya. The colour of the pileus varies, some examples being yellow with only a slight ashy covering, while in others the grey streaks almost entirely hide the yellow. The stalk is usually pale yellow, but some examples have a white stalk. A form occurs without any trace of yellow in the pileus or stalk.

Pluteus stigmatophorus B. & Br. Pileus up to 3·5 cm. diameter, broadly convex or almost plane, centre depressed, becoming repand and subinfundibuliform, black-brown in the centre, the cuticle elsewhere broken into minute black-brown scales or points arranged somewhat radially, pallid, then pinkish, between the scales. Stalk white or pallid, subtranslucent, up to 3·5 cm. high, 3 mm. diameter, equal or slightly expanded upwards, stuffed then hollow, glabrous above, with a few fibrils below which turn blackish when handled, or mealy with minute black granules, base slightly white tomentose, often swollen. Gills free, ventricose, rounded at both ends, white then pink; cystidia on the edge of the gills in scattered groups forming more or less conical fascicles, ovate, up to 24 μ high, 16 μ diameter, or flask-shaped, 60 μ high, 20 μ diameter below, 6 μ diameter above, minutely verrucose, usually with an amorphous cap. Spores pink in mass, smooth, globose, 4-7 μ, or broadly oval, 5-7 × 4-5 μ. On dead wood, Peradeniya.

I know this species only from examples which develop on stumps of tea and rubber kept in pots under bell glasses at the laboratory. These are usually small. The type painting shows a larger specimen, 4 cms. high, 3·5 cm. diam., markedly repand. There is very little difference between the type paintings of *Pluteus stigmatophorus* and *Pluteus escharites*, and the former was re-described under the latter name in Ann. Perad., VI, p. 314. It differs from *Pluteus escharites*, as far as can be determined from the herbarium specimens, only in the shape of the cystidia.

The cystidia collapse and are difficult to detect on dried specimens. There is only one sheet, Thwaites 918, in Herb. Kew, and this bears halves of two specimens, and median longitudinal sections of three. The spores on the specimen examined by me were smooth, globose, 4-5 μ diameter.

Pluteus pulvinus B. & Br. Recent specimens which are considered to belong to this species have a pileus up to 4 cm. diameter, broadly campanulate, obtusely umbonate, pale greyish brown and minutely squarrose in the centre, elsewhere lightly radially streaked with greyish brown, innately radially silky, sulcato-striate at the margin. The flesh is very thin, practically absent except over the stalk. The gills are rather distant, ventricose, very broad (up to 7 mm.), free, but close to the stem, white, then salmon pink. The stalk is curved, white, longitudinally striate, glabrous, solid, up to 3·5 cm. high, 3 mm. diameter. The spores are globose, 5-6 μ diameter, or broadly oval, 5-6 × 4-5 μ. Indian red in mass when moist. It has scanty cystidia, flask-shaped, up to 50 μ high, 16 μ diameter. The specimens grew on the standing trunk of a dead jak tree.

Berkeley and Broome described *Pluteus pulvinus* as " Pileo convexo fortiter umbonato striato particulis pulveraceis consperso ; stipite subaequali solido ; lamellis latis ventricosis approximatis." They cited Thwaites 757***, *cum icone*. There is, however, no figure of this species in Herb. Kew or Herb. Peradeniya. Thwaites 757** and 757*** were sent together on the same sheet, and there is a figure of the first of these only, viz. *Pluteus conizatus*.

Pluteus balanatus B. & Br. This was described from a painting of an unexpanded specimen. The fully-expanded pileus is up to 3 cm. diameter, membranous, broadly convex, depressed in the centre, sulcato-striate on the outer half, diaphanous, pinkish when moist, becoming ashy or faintly yellowish in the centre on drying. The centre is usually smooth, but may be broken into small scales.

The gills are free, rather distant, very ventricose, up to 5 mm. broad, diaphanous then pinkish. The stalk is white, translucent, pruinose, up to 2 cm. high, 3 mm. diameter, slightly attenuated upwards. The spores are globose, 4-6 μ diameter, or oval, 8 × 6 μ. The cystidia on the edge of the gills are ovoid, 40 μ high, 16 μ diameter, or flask-shaped, 40 μ high, 14 μ diameter below, 6 μ diameter above. On examination of the fresh specimens with a lense, the faces of the gills appear to bear cystidia, but these prove to be projecting hyphae, up to 100 μ long and 4 μ diameter. The recent specimens grew on wood.

A previous spore measurement on fresh specimens gave the dimensions, 7-8 × 5-6 μ, broadly oval, or 7 μ, globose.

Pluteus eugraptus B. & Br. Pileus up to 3 cm. diameter, plane, with a strongly developed, obtuse umbo, tawny, centre yellow brown, striate almost to the umbo ; flesh thin. Stalk up to 2 cm. high, 2-3 mm. diameter, expanding upwards, glabrous, yellow brown, white internally, stuffed, slightly tomentose with white tomentum at the base. Gills pink, ventricose, broad (4 mm.), rather distant, free. Spores pink, narrow oval, 7-9 × 4μ. On dead wood.

The type appears to be immature, and the spores found in it were oval, 4 × 3 μ. Berkeley and Broome gave the spores as subglobose or broadly elliptic, 6 μ long.

Pluteus flavo-marginatus Petch, Ann. Perad., VII, p. 282. Pileus about 2 cm. diameter, convex, sometimes slightly umbonate, orange red, sometimes with deeper crimson radial streaks, margin yellow. Gills white, then pink, broad, somewhat ventricose, free. Stalk up to 3·5 cm. high, 2 mm. diameter, yellow, glabrous, slightly tomentose at the

base. Spores pink, subglobose, 5-6 × 4-5 μ. Frequent at Hakgala on dead wood.

This species does not appear to have been collected by Thwaites, probably because the majority of his agarics were collected at Peradeniya, where this apparently does not occur.

Pluteus chrysaegis (B. & Br.) Petch; *Entoloma chrysaegis* B. & Br. Fungi of Ceylon, No. 182. Pileus 2·5-4 cm. diameter, broadly convex, golden yellow, fuscous in the centre, becoming brown when old, glabrous, margin striate, feebly sulcate when old. edge pale; flesh thin, white, becoming yellow. Stalk up to 3·5 cm. long, 2-3 mm. diameter, slightly attenuated upwards, white, becoming yellowish at the base, longitudinally striate, sometimes twisted, powdered below, glabrous above, solid. Gills free, crowded, rounded behind, up to 4 mm. broad. equal, white then pink. Spores salmon pink in mass, globose, smooth, 4-6μ diameter. On decaying stumps, Peradeniya.

The type painting shows the centre of the pileus depressed. *Pluteus conizatus* B. & Br., according to the figure of the latter, has an umbonate pileus and yellow stalk.

Pluteus escharites B. & Br. Judging from the type painting, this species closely resembles *Pluteus stigmatophorus*, and the descriptions of the two species do not reveal any marked differences. Berkeley and Broome cited Thwaites 868, *cum icone*, as the type. In Herb. Kew there are three collections under this number. On one sheet, the pilei are striate up to half way to the centre; on another they are feebly striate; and on the third strongly striate. The Ceylon label is attached to the second of these, which is nearest the type figure in general stature, though none of the specimens is the one from which the figure was drawn, that being Thwaites 868 in Herb. Peradeniya. The first of the three sheets is *Pluteus stigmatophorus*, while the specimens on the third have strongly angular spores and are an *Entoloma*.

Pluteus escharites has smooth spores, either globose, 4-5 μ or oval, 6×4 μ; and the microscopic structure of the cuticle is similar to that of *Pluteus stigmatophorus*. But it differs from the latter in having globose cystidia, 15-17 μ diameter, or obpyriform cystidia, 15 × 21 μ, scattered over the face of the gills and along their edges. It has not been collected recently. Massee stated that *Pluteus escharites* had no cystidia, and that the spores were elliptic-fusiform, very minutely warted, 10 × 6 μ. It is possible that he may have examined the *Entoloma* specimens.

Pluteus phlebophorus Ditm. The Ceylon specimens attributed to this species were sent by Gardner, accompanied by a painting. The

specimens are *Oudemansiella apalosarca* (B. & Br.), and the painting is a good representation of small examples of that species.

Pluteus aglaotheles B. & Br. This was Thwaites 1189, with a painting. Berkeley and Broome noted that it had urn-shaped cystidia, and there is a figure of the cystidia with the type in Herb. Kew. These cystidia are cylindric, slightly inflated below, with a rooting base, or flask-shaped with a rooting base, the total length being about 56 μ and the diameter up to 15 μ ; the apex is divided into three or four conical spines, about 10 μ long. The spores are oblong-oval, apiculate at one corner. 5-8 × 3-4 μ, or globose, 5 μ. The pileus in the type is somewhat spongy, as noted as Berkeley and Broome, but it has been hollowed out by insects. Thwaites 917 was described by Berkeley and Broome as *Pluteus subcervinus*. Massee stated that it possessed cystidia, more or less ventricose, with the apex crowned by a varying number of spicules, but he did not notice that these were exactly the cystidia figured by Berkeley and Broome for *Pluteus aglaotheles*. The spores of *Pluteus subcervinus* are identical with those of *Pluteus aglaotheles*. Unfortunately there was no painting of *Pluteus subcervinus*. It was said to have a livid brown pileus, but that was deduced from the dried specimen. On the evidence of the spores and cystidia, *Pluteus subcervinus* and *Pluteus aglaotheles* are the same. This species has not been collected again.

Pluteus albolineatus B. & Br. This was described from Thwaites 757, and a painting. The figure shows a specimen of the stature of *Pluteus glyphidatus*, blackish brown with white radial streaks, the latter being due to the splitting of the surface layers of the pileus. On the dried specimen the dark narrow bands of the surface layer anastomose. The spores are globose, 4-5 μ diameter, or oval, 6 × 5 μ ; cystidia have not been found. Thwaites 757 was considered by him a mixture. To his number 915, he added the note, "sent before under No. 757, which comprised more than one species, I believe," and to No. 925, "sent before intermixed with 757, Compare No. 760 and 795." No. 915 was named *Pluteus psichiophorus* B. & Br.; its pileus is radially streaked, but the dark streaks are broken ; its spores are globose, 4-5 μ, or oval, 6 × 5 μ ; cystidia have not been observed in the herbarium specimens. No. 925 was named *Pluteus aeolus* ; its spores are globose, 4-5 μ, or oval, 5-6 × 4-5 μ : cystidia have not been found in the herbarium specimens ; the surface of the pileus is broken into minute black warts, sometimes radially arranged. Thwaites 760 bis was referred by Berkeley and Broome to *Pluteus nanus* P.; its spores are globose, 4-6 μ, or oval, 5 × 4 μ, and the surface of the pileus is split into minute black warts. *Pluteus brunneopictus* B. & Br. was Thwaites 916 ; Thwaites stated that it

differed only from 915 in the marking of the pileus when seen by transmitted light. There are apparently two species in the type of *Pluteus brunneopictus*, one with spores 4-6 × 3, and the other with spores 6-9 × 5 μ : the pileus of the former is streaked or split radially, while that of the latter is broken up into minute warts.

Thwaites sent figures of two of the above species only, viz. *Pluteus albolineatus* and *Pluteus brunneopictus*. The latter figure would appear to have been drawn from a specimen with the smaller spores ; Berkeley and Broome gave the spores as ovate. and 6 μ long. *Pluteus albolineatus* and *Pluteus brunneopictus* would appear to be different, but it seems very doubtful whether *Pluteus psichiophorus*, *Pluteus aeolus*. and the Ceylon *Pluteus nanus* are distinct from *Pluteus albolineatus*. None of these has been recognised recently.

Pluteus grandineus B. & Br. The type contains parts of two examples. Berkeley and Broome stated that the pileus was covered with minute powdery warts, but this is true only of one specimen. and the warts are masses of spores. The spores are oval, 6-8 × 5 μ, or globose, 5 μ. It appears to be a species of the stature of *Pluteus pulvinus* B. & Br., but its spores differ from those of the latter. It has not been collected recently.

Pluteus marmoratus B. & Br. This, from the figure, is a stout species, the stature of *Pluteus spilopus*, but differs from *Pluteus spilopus* in colour, and in growing on wood. The marbling of the pileus is probably due to insect borings. There is no specimen in Herb. Peradeniya. and I have omitted to examine the Kew specimens. It has not been recognised recently.

Pluteus pelinus B. & Br. The spores of this species are broadly oval, 7-8 × 5-6 μ, or globose, 5-6 μ. Cystidia were not found in the type. This is a small species, growing on wood. It has not been collected recently.

Pleutus fusco-nigricans B. & Br. This species would appear to resemble *Pluteus pulvinus* B. & Br., in its general shape, striate pileus, and broad gills, but the figure shows a much darker pileus, and its spores are 5-6 × 4-5 μ, broadly oval.

Pluteus conizatus B. & Br. This was said to have the surface broken up into minute powdery patches, at length leaving the substratum exposed in parts. It was sent with the specimens named *Pluteus pulvinus*,

and Berkeley and Broome stated that in the latter the cuticle did not chip off as in *A. conizatus*. The figure shows a large species, exactly the size and stature of the wet weather form of *Pluteus spilopus*, and it would agree with the latter in that the cuticle chipped off. But the coloration of the pileus is not that of *Pluteus spilopus*, and it has a yellow stalk, while the spores are globose, 4-5 μ, or oval, 5 × 4 μ, with a well-marked apiculus. Cystidia were not found on the herbarium specimen. This species would appear to be distinct from both *Pluteus spilopus* and *Pluteus pulvinus*. It has not been collected recently.

Pluteus flavipes Petch, n. sp. Pileus 1 cm. diam., broadly convex, almost plane, pale yellow-brown, rugulose, margin striate. Stalk 1·5 cm. high, 1 mm. diameter, pale yellow, translucent, glabrous, slightly attenuated upwards, base slightly bulbous. Gills rather distant, broad, ventricose, erose behind, free, but close to the stem. Spores globose, 5-6 μ diameter. Cystidia not found. On dead wood, Peradeniya. October 15, 1914 ; specimen and painting, No. 4180 in Herb. Peradeniya.

ENTOLOMA

Entoloma purpureum Petch, n. sp. Pileus up to 8 cm. diameter, conico-campanulate, becoming broadly conico-campanulate, apex obtuse or slightly depressed, deep violet purple, almost black in the centre, densely covered with minute violet black scales ; margin striate; splitting when old ; flesh thin, bluish white. Stalk up to 8 cm. high, 6 mm. diameter, bluish violet, paler than the pileus, or pale blue, sparsely fibrillose, equal, or attenuated upwards, usually curved at the base, densely stuffed, then partly hollow, white, becoming bluish or greenish, internally. Gills broad (up to 1 cm.), attenuated outwards, rounded or truncate behind, with a decurrent tooth, rather distant. Spores brownish pink in mass, angularly ellipsoidal, 10-14 × 7-8 μ. On the ground among dead leaves.

Berkeley and Broome referred this species (Thwaites 799) to *Entoloma ardosiacum* Bull., var. *agauum* B. & Br., and to *Entoloma griseocyaneum* Fr., var. coloribus saturatioribus. The painting of the former shows a violet purple pileus and an indigo-blue stalk, while in the painting of the latter both the pileus and the stalk are indigo-blue.

Entoloma iodnephes B. & Br. The type painting of this species shows specimens with a violet pileus, and a pale violet or almost white stalk. Two specimens are conico-campanulate, more acute than *Entolo-*

ma purpureum, while the third is repand and cyathiform. It might be taken for a form of *Entoloma purpureum*, but it is apparently caespitose, and has smaller spores, angular ellipsoidal, 6-8 × 4-5 μ. The cyathiform specimen has a fistulose stalk which is probably abnormal. Berkeley and Broome gave the dimensions of the spores 7·5-10 × 5-7·5 μ ; Massee stated that they were angularly globose, 8-10 μ.

Entoloma retroflexum B. & Br. The type painting of this species shows a pileus 1 cm. diameter, and a flexuose stalk, 3·5 cm. high, 1 mm. diameter. In the type specimen the gills are very thick, and are rather closely encrusted with masses of calcium oxalate. Berkeley and Broome stated that the spores were angular, but it would seem probable that crystals of calcium oxalate were mistaken for spores. Massee stated that the spores were globose, with a slight indication of angular irregularities, 5 μ diameter, and added that it was "undoubtedly a species of *Hebeloma* ; the gills are pale ochraceous-tan, the spores are also tinged with the same colour and do not show a trace of red or pink." Few spores are to be found on the co-type in Herb. Peradeniya. After dissolving away the crystals, the spores seen were oval, inequilateral, smooth, 6-8 × 3-4 μ ; no colour was observable in them, and it is quite possible that they may be white in mass. This species has not been collected again.

Entoloma chrysaegis B. & Br. This has been re-described as *Pluteus chrysaegis* in Ann. Perad., V, p. 271.

Entoloma rhodopolium Fr. The Ceylon fungus assigned to this species by Berkeley and Broome has been re-described as *Entoloma infundibuliforme* in Ann. Perad., VI, p. 315.

Entoloma sericeum Bull. Thwaites 869, *cum icone*, was referred to this species by Berkeley and Broome as var. stipite fibrilloso-farcto. No specimens resembling the figure have been collected recently. The spores are oval, nodular, with a short, conical apiculus, 10-12 × 5-8 μ.

Entoloma mazophorum B. & Br. The spores of this species are angular, quadrate with a large conical apiculus, or sub-pentagonal, 9-10 × 6-7 μ. It has not been collected again.

Entoloma microcarpum B. & Br. This species was re-described in Ann. Perad., III, p. 255. Patouillard, Bull. Soc. Myc. France, XXIX, p. 210, refers it to *Mycena*.

Entoloma intermixtum B. & Br. The specimens named thus by Berkeley and Broome are larger specimens of *Entoloma microcarpum*.

Entoloma stylophorum B. & Br. This was re-described in Ann. Perad., VI, p. 315.

Entoloma pallido-gilvum B. & Br. There was no painting of this species, and Berkeley and Broome did not give the colour, except that the whole plant became umber in drying. The name, however, was probably derived from Thwaites's note on the specimen, " whole plant pale gilvous." The spores are more or less quadrate with a prominent conical apiculus, or pentagonal, 6-8 × 5 μ. Massee gave the spores as broadly pyriform, apiculate at the base, even, or sometimes very slightly angular, 6 × 5 μ They are certainly angular. This species has not been recognised again. It would appear to be rather close to *Entoloma mazophorum*.

Entoloma argilophyllum B. & Br. There was no painting of this species, and the statements concerning its colour must have been based on the dried specimen. Berkeley and Broome stated that there might be some doubt as to the proper position of this species as they had not seen the spores. They described the gills as beset with little dark particles. The vertical section looks very much like that of a *Marasmius*, and the gills are distant, forked, and united by cross veins here and there.

Massee gave " spores elliptical, smooth, 8 × 5 μ, pale dingy ochraceous ; cystidia cylindrical, 70-80 × 12-14 μ, abundant. The present species is a true *Hebeloma* ; gills very ventricose, 2 lines broad in the middle, deeply sinuate, and almost free, dry and thin, pale dingy tan."

The cystidia are up to 80 μ long, 16 μ diameter above, contracted rather suddenly at about one third their height into a stem-like base, 5 μ, diameter, thick-walled, minutely verrucose. The dark particles noted by Berkeley and Broome are brown, and are shortly cylindrical, up to 10 μ long, 8 μ diameter, or irregularly ovoid. They readily break up into irregular fragments, and are the contents of cells which just reach the surface of the gill or project slightly above it. The same coloured masses occur in the stalks of the cystidia. Spores were not found on the type specimen. Massee would appear to have measured the brown masses. This species has not been recognised again.

Entoloma crassipes Petch, n. sp. Often caespitose ; when young, convex, slightly umbonate, margin regular and incurved, becoming depressed or feebly umbonate, wavy, margin irregularly decurved, or

repand, up to 10 cm. diameter, white or cream-coloured, sometimes faintly ochraceous in the centre, smooth. Stalk stout, up to 11 cm. high, 3 cm. diameter, equal, or fusiform, or expanding upwards, white, at first fibrillose, the outer layers frequently splitting so that the stalk is lacunose, solid, white and spongy internally, base white tomentose. Gills rather distant, narrow, attenuated outwards, sinuato-decurrent, edge often irregular, white, becoming pale pink. Spores pale pink in mass when dry, but with a brown tinge when wet, very pale brown by transmitted light, oval, coarsely warted, 5-7 × 3-4 μ.

This is a common species among dead leaves or on rubbish heaps at Peradeniya, but I have not been able to trace it among the specimens described by Berkeley and Broome.

Entoloma brunneum Petch, n. sp. Pileus up to 3 cm. diameter, convex, or conico-convex, with a prominent rounded umbo, pale brown or bay brown, clothed with minute squarrose scales, especially in the centre, and minutely radially silky ; margin uneven, striate when old ; flesh thin. Stalk 6-7 cm. long, 3-5 mm. diameter, slightly attenuated upwards, of the same colour as the pileus, with a few dark fibrils, longitudinally striate, twisted, base white and tomentose, internally white, stuffed then hollow. Gills distant, broad, ventricose, in three series, the longer sinuato-adnate, white, then pallid, finally pink. Spores Indian red in mass when moist, pale red when dry, angular, generally quadrilateral in plan, 8-12 μ broad, guttulate. Cystidia not found. On the ground among grass, Peradeniya, Nov. 14, 1911 ; No. 3272 in Herb. Peradeniya.

The shape of the pileus is that of *Entoloma mazophorum*, but the colour is different, the stalk longer, and the spores larger and different in shape.

LEPTONIA

Leptonia gnaphalodes B. & Br. Pileus 2 cm. diameter, almost plane, centre umbilicate, greyish brown, with paler radial streaks, minutely scaly, especially in the centre. Stalk 2·5 cm. high, 1·2 mm. diameter, expanding at the apex, greyish pallid, pellucid, feebly longitudinally fibrillose, base white tomentose. Gills moderately distant, ventricose, adnate with a decurrent line. Spores pink in mass, angular with a short conical apiculus, 8-12 × 6-8 μ. Cystidia not found. On the ground.

Leptonia gnophodes B. & Br. Pileus up to 3 cm. diameter, deeply infundibuliform with a plane or decurved margin, or convex, or conico-

convex, sometimes truncate above, when moist deep brown, glabrous, strongly striate, becoming grey with the surface split into small, innate, dark grey scales when dry. Stalk up to 6 cm. high, 3mm. diameter, greyish brown, pellucid, glabrous, pruinose at the apex, equal, or expanding upwards, often flattened at the apex, curved and white tomentose at the base, hollow, brown internally. Gills broadly ventricose, or with the lower edge even, pinkish brown with a pale edge, adnate, or adnate with a decurrent tooth, or decurrent. Spores angularly globose, 8-12 μ diameter, or oval, 8-10 × 6-8 μ. Cystidia flask-shaped, inflated at the apex, or nine-pin shaped, up to 64 μ high, 12-24 μ diameter below. On the ground among grass, sometimes in a ring.

This species occurred in my garden at Peradeniya, and the various shapes described are from specimens from the same patch. Normally it is infundibuliform, but some specimens are convex or conico-convex. In some forms it is rather *Eccilia*.

Berkeley and Broome described this species from Thwaites 841 *cum icone*, and stated that it was mixed with *Leptonia serratulus*. There were three paintings, which they named *Leptonia gnophodes*, *Leptonia serratulus*, and *Leptonia serratulus* var. with a solid stem. The last named is undoubtedly the same as *Leptonia gnophodes*. The figure assigned to *Leptonia serratulus* is bluish grey. This coloration does occur in some stages of drying in *Leptonia gnophodes*, and the figure could not be separated from the others on that character. But it also shows dark blue points on the gill edge, a feature which I have not observed in *Leptonia gnophodes*.

NOLANEA

Nolanea apiculata Petch, n. sp. Pileus up to 2 cm. diameter, broadly campanulate or almost plane, with an acute umbo sometimes produced into a cylindrical tip about 1 mm. high, sometimes depressed round the umbo, blackish brown, paler at the margin, radially silky, striate when moist, thin, almost membranous. Stalk up to 4 cm. high, 2 mm. diameter, pale brown, slightly attenuated upwards, glabrous, or with a few longitudinal fibrils, strigose at the base, cartilaginous. Gills brown then pink, moderately crowded, ventricose, rounded or attenuated behind, free but close to the stem. Spores pink, nodular, angularly oval with a long conical apiculus, 8-12 × 5-7 μ. On the ground, Peradeniya, October 18th, 1914; specimens and painting, No. 4189 in Herb. Peradeniya.

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Agaricaceae Pleuropodes Zeylanicae

BY

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The following list includes descriptions of the species of *Pleurotus*, *Claudopus*, and *Crepidotus* recorded for Ceylon by Berkeley and Broome, and of other species of the same genera recently collected.

PLEUROTUS

Pleurotus reticulatus Petch, Ann. Perad., VI, p. 198. Stalked; pileus 6-12 cm. diameter, infundibuliform, outer half at first decurved, then almost wholly infundibuliform, yellow brown in the centre, yellow or brownish yellow elsewhere, blackening in the centre and becoming paler at the margin when old, glabrous, margin not striate; total height 6-9 cm.; flesh white over the gills, becoming yellow over the stalk. Stalk 3-3·5 cm., high, 1-1·4 cm. thick, equal, expanding into the pileus, expanding slightly at the base, golden yellow, reticulated with red brown lines of innate fibrils, solid, slightly tomentose at the base, excentric, internally golden yellow or golden brown. Gills yellow, becoming pallid when old and turning green on drying, decurrent, continued down the stem in lines of four lengths which frequently anastomose, crowded, broad, arcuate, edge slightly irregular. Spores white, globose or broadly oval, 4·5-6 μ diameter. On dead wood, Hakgala, April 1912, September 1914; type, No. 3536 in Herb. Peradeniya; painting, No. 4132.

Pleurotus dryinus P. This species was recorded for Ceylon by Berkeley (Hooker's London Jour. Bot., VI, pp 479-514) among the fungi sent by Gardner, No. 88. There is no specimen in Herb. Kew, and the paintings No. 88, sent by Gardner, are marked "Hantane (no specimen)". The figures show a deeply infundibuliform species which has narrow, crowded gills and a central stalk, with a collar on the stalk. They are quite a good representation of *Lentinus Sajor-Caju*. The name *Pleurotus dryinus* should therefore be deleted from the Ceylon list.

Pleurotus angustatus B. & Br., Fungi of Ceylon, No. 141. Caespitose or scattered; pileus violet grey, sometimes amethyst, at first,

paler towards the base, becoming pale livid brown when old and sodden, orbicular, sometimes circular, or spathulate, sometimes obliquely infundibuliform, glabrous, upper layer subtranslucent, up to 8 cm. diameter, or 10 × 5 cm., margin at first inrolled. Flesh white, thin except over the stalk. Stalk stout, excentric, sometimes almost lateral, but in the latter case margined above by a continuation of the pileus without gills, up to 4 cm. high, 1·3 cm. diameter, white, even or ridged or reticulated, glabrous or nearly so. Gills dead white, rather crowded, decurrent or occasionally sinuato-decurrent, narrow. Spores white, oblong-oval, slightly inequilateral, 8-12 × 4-5 μ.

Pleurotus flabellatus B. & Br., Fungi of Ceylon, No. 145; *Pleurotus scytocephalus* B. & Br., Fungi of Ceylon, No. 146; *Pleurotus leptogramme* B. & Br., Fungi of Ceylon, No. 147. Caespitose or scattered, often arising in tufts from an extended basal stroma; white, or white with a pinkish tinge, or in dry weather, mouse grey above with salmon pink gills; flabelliform, orbicular, or reniform, with a short stem-like base, sometimes shortly stalked, glabrous when moist, innately radially silky in dry weather, or becoming tomentose towards the base, margin entire or lobed, up to 11 × 7 cm. Gills white, rather crowded, decurrent usually to the base of the pseudostalk, sometimes anastomosing below; base of pseudostalk, or stalk if present, tomentose or strigose. Spores white, oblong-oval, inequilateral, apiculus excentric, 6-10 × 3-4 μ.

There are two forms of this species, which are distinct in habit, but do not appear to be distinguishable by any definite morphological characters. One of these grows on fallen branches, or decaying palm stems, or stems of soft wood trees, *e.g.*, dadap; in this form the fungus is usually white, rarely pinkish behind, thin, tender, often lobed and undulating, glabrous when moist, with a matt surface when dry, and occurs singly, or in tufts of two or three connate at the base, but without a definite basal cushion. The second form occurs on wounds caused by fire injury, etc., on living trees, *e.g.*, *Hevea*, and arises in large clusters from stout basal cushions which often originate from cracks or beetle-holes and extend for some distance over the surface of the wood. This second form is stouter, and examples which appear in the drier weather towards the close of the rains are mouse grey with a slight pinkish tinge above, and salmon pink below. The pink colour soon fades.

The pileus in wet weather appears glabrous, but in drier weather innately radially silky. As the pilei age, a slight tomentose growth extends from the base towards the margin. Specimens which appear radially silky when fresh have a matted, finely tomentose surface when dry, except near the margin.

From the descriptions and specimens, *Pleurotus flabellatus* is the thin, tender form, while *Pleurotus leptogramme* is the stouter form with a well-developed basal cushion. The latter was apparently described from specimens on which the thin tomentose covering was well developed, but glabrous specimens occur in the type collection. The fine lines towards the margin, noted by Berkeley and Broome for *Pleurotus leptogramme*, appear only on drying; they may extend radially to the margin almost from the base and depend upon the condition of the fungus when gathered.

Pleurotus scytocephalus was said to differ from *Pleurotus flabellatus* in having smaller spores, 6 μ long. This measurement is within the limits of the dimensions of the spores of the latter. The type of *Pleurotus scytocephalus* in Herb. Kew contains two small specimens, which appear to be merely immature examples of *Pleurotus flabellatus*.

Pleurotus versiformis Berk., Hooker's London Jour. Bot., VI, p. 479. Berkeley's description is as follows.—Hygrophanous, white; pileus membranaceous, umbilicate, infundibuliform, flabelliform, spathulate, or sub-linear; stalk short, glabrous or sprinkled with a few strigose fascicles, sulcate, cartilaginous when dry; gills rather broad, attenuated behind, decurrent, interstices rugulose. Like *Pleurotus petaloides*, but not closely allied; might rather be referred to *P. mutilus*.

Gardner's specimen is in Herb. Kew. It was apparently gathered in bad condition and is scarcely recognisable. It might be *P. flabellatus*, but the description does not fit that species.

Pleurotus polychromus B. & Br., Fungi of Ceylon, No. 143. Orbicular, convex, strongly elevated and sub-umbonate behind, up to 3·5 cm. broad and 3 cm. long, deep purple-brown, becoming red-brown towards the margin, extreme margin pale or white; when old entirely red brown; glabrous when moist, very minutely silky when dry; margin inrolled at first; flesh thick, white. Stalk excentric, almost lateral, short, stout, up to 4 mm. high, 4 mm. diameter, minutely tomentose. Gills white, becoming spotted red where bruised, blackening in drying, rather crowded, narrow, no cystidia. Spores white, narrow-oval, inequilateral, 4-6 × 2- 3 μ.

Pleurotus rigescens B. & Br., Fungi of Ceylon, No. 142. This species was described by Berkeley and Broome from Thwaites 695, *cum icone*, numbers 97 and 88 in part being also cited. Thwaites 695 is undoubtedly *Pleurotus polychromus*, and the figure is that species; the colour of the pileus is red brown. The figure from which Berkeley and Broome described *Pleurotus polychromus*, Thwaites 960, is the

younger stage, the pileus being purple-brown. In Herb. Peradeniya, Thwaites 88 and 695 are mounted on one sheet ; the specimens include *Pleurotus polychromus*, *Pleurotus testudo*, and a *Marasmius*. In Herb. Kew, *sub Pleurotus rigescens*, are Thwaites 695, 87, 88, and 97. No. 695 is *Pleurotus polychromus* ; No. 87 is *Crepidotus phaeophyllus* Berk.; No. 88 is a *Marasmius*. I regret that I have mislaid my notes on No. 97, and that number is apparently not represented in Herb. Peradeniya. Berkeley and Broome's description, however, is drawn up chiefly from Thwaites 695, which is *Pleurotus polychromus*, but in view of the confusion of specimens under *Pleurotus rigescens*, it would seem preferable to retain the former name.

Pleurotus galeaeformis B. & Br., Fungi of Ceylon, No. 144. Berkeley and Broome's description of this species is as follows,- Pileus 1·8 cm. across and as much high, oblique, helmet-shaped, thin, striate, pale in front, rufous behind ; stalk cylindric, 2 lines high, not a line thick, polished, arising from a fuscous, orbicular base ; gills broad, pale ochraceous, interstices veined. Thwaites No. 1207, *cum icone*, was cited. There is no figure, No. 1207, in Herb. Peradeniya, nor among the copies in Herb. Kew. The type in Herb. Kew contains a specimen and a half, resembling in shape *Favolaschia bispora*, but stalked.

Pleurotus pseudobarbatus Petch, n. sp. Sessile, orbicular or flabelliform, up to 2 × 1·5 cm., pale ochraceous, becoming dark-brown when old, covered behind with white spongy tomentum, which becomes fasciculate in front, margin glabrous; tomentose round the base ; gills pallid, becoming pale brown to grey brown, the longer broad and ventricose, the shorter lower, so that the gills appear more or less distant, margin lacerate ; spores white, broadly oval or subglobose, 4 × 3 μ. On a dead branch, Peradeniya, June 25, 1919 ; specimen and painting, No. 6016 in Herb. Peradeniya.

The white tomentum forms a spongy layer, with a smooth outer coat, but in front is broken up into scattered erect fascicles ; it is composed of hyphae 2 μ diameter, usually thin-walled. The gills are rather thick, and their context contains irregularly distorted, thick-walled or almost solid hyphae, 3-4 μ diameter.

Pleurotus testudo Berk. Pileus semi-elliptical or orbicular, regular, up to 2·5 cm. broad, sometimes irregularly lobed and up to 5 × 2·5 cm., sessile, convex, more or less umbonate at the point of attachment, grey or brownish grey, paler towards the margin, becoming brown when old and sodden, sometimes white, tomentose behind with minute, erect,

scattered fascicles of white hairs, margin faintly radially striate. Flesh subgelatinous, but the pileus not viscid. Gills rather distant, narrow, white, becoming brown when old, bearing numerous prominent cystidia. Cystidia fusoid, 50-70 μ long, 12-14 μ diameter, the free part conical or flask-shaped, thick-walled below, solid or with a narrow central cavity above, yellow in dried specimens. Spores white, oblong, ends rounded, 5-7 × 2·5 μ.

This species is not uncommon at Peradeniya. It was sent to Berkeley by Gardner, and was described in Hooker's London Journal of Botany, VI, p. 484. In the Fungi of Ceylon, Berkeley and Broome stated that it is *Agaricus barbatus* B. & C. in part, and refer to Cuba, No. 44. But it was described before any Berkeley and Curtis specimens, and so cannot be any of their species in part. Moreover, Wright's specimen No. 44 in Cuban Fungi is *Pleurotus barbatulus* B. & C., described in 1859.

In Saccardo, Sylloge, XI, p. 62, it is stated, on the authority of Cooke, that *Pleurotus testudo* is a *Crepidotus*. That is incorrect.

Pleurotus sub-barbatus B. & C., Journ. Linn. Soc., X, p. 288. Sessile ; flabelliform, orbicular, or elongated, up to 1 cm. diameter, slate coloured to blackish brown, densely strigose with coarse, greyish, adpressed fascicles from the base over two-thirds or three-quarters of the pileus, feebly silky, appearing glabrous, over the marginal zone ; margin radially striate when moist. Gills brownish black, crowded, narrow : no cystidia. Spores white, oval or oblong-oval, 5-6 × 3·5-4 μ. The strigae extend over the wood round the base of the fungus ; they consist of thick-walled, hyaline hyphae, 2-3 μ diameter, sometimes united into long, brown, tapering fascicles, 30 μ diameter.

Pleurotus semisupinus B. & Br., Fungi of Ceylon, No. 151. Sessile : at first globose, with a minute central orifice, then expanded, circular, saucer-shaped, up to 3 mm. diameter, with a white, tomentose, central papilla, about 0·3 mm. diameter; white, hymenium becoming tan coloured; externally densely radially strigose. Gills distant, subventricose, attenuated behind, arising near the central papilla, covered with crystals of calcium oxalate ; cystidia fusoid, with a long point, 24-26 × 8-12 μ, or obconoid or irregularly triangular, up to 30 μ high, including a curved horn, 6-12 μ long, at each corner. Spores oval, inequilateral, 4-6 × 2-2. 5 μ. Hairs on exterior hyaline, flexuous, thick-walled, 2-3 μ diameter.

Pleurotus gelatinosus Petch, n. sp. Pileus up to 1 cm. diameter, sessile, usually circular and centrally attached, sometimes orbicular

and attached laterally, subgelatinous, pale slaty grey, becoming dark slate, and finally blackish brown or black, pruinose round the point of attachment, the pruina appearing rusty on dried specimens ; margin even when young, becoming crenate when old ; black internally. Gills moderately crowded, rather broad, at first grey, then dark slate, finally blackish-brown with a pale grey edge ; no cystidia. Spores white, globose, 4-5 μ diameter.

This species was Thwaites 391, and was included by Berkeley and Broome under *Pleurotus subbarbatus* B. & C. as " a tender variety which comes very close to *A. striatulus*. This at length collapses and clings close to the matrix. " The " collapsed " position, flat on the wood, is the natural habit.

SCHIZOPHYLLUM

Schizophyllum commune Fr. Berkeley and Broome enumerated two species of *Schizophyllum* from Ceylon, viz. *Schizophyllum commune* Fr. and *Schizophyllum multifidum* Fr. Bresadola, in Ann. Myc., IX, p. 549, refers to the second as " *Schizophyllum commune* var. *multifidum* (Batsch) Fr. in Berk. Fung. Ceylon, No. 430. " These are merely forms of the same species. It is not possible to maintain the second distinct, even as a variety. The spores of *Schizophyllum* are white or pale yellow in mass, hyaline by transmitted light, oblong-oval or cylindric, with the apiculus at one corner ; measurements at Hakgala (5600 ft.) gave the dimensions, 4-6 × 2 μ, at Peradeniya (1600 ft.) 5-7 × 2·5-3 μ.

CLAUDOPUS

Claudopus fusco-lamellatus Petch, Ann. Perad., VI. p. 200. Sessile; orbicular or flabelliform, up to 7 × 5 cm., cream coloured, smooth behind, sometimes slightly tomentose towards the margin ; margin incurved ; gills slightly fuscous, blackening in drying, narrow, crowded ; spores salmon pink in mass, oval, inequilateral, 4-5 × 2-3 μ. On a decaying tree trunk, Hakgala, April 1914 ; No. 4061 in Herb. Peradeniya.

Claudopus repens Petch, Ann. Perad., VII, p. 282. Resupinate, sessile, orbicular, up to 4 mm. diameter ; margin white, tomentose ; hymenium pinkish red ; gills few, distant ; spores irregularly globose, nodular, with a stout conical apiculus, 6-8 × 4-6 μ. On the under side of rotting logs, arising from white cords of mycelium which spread out here and there into cobwebby sheets. Hakgala, December 1917 ; No. 5621 in Herb. Peradeniya.

CREPIDOTUS

A. Spores smooth

Crepidotus flavomarginatus B. & Br., Fungi of Ceylon, No. 238. Shortly stalked ; pileus at first galeate, becoming convex or almost plane, orbicular, 1-1·6 cm. broad, pale yellow, pale ochraceous, or orange, clothed with adpressed flocci, sometimes glabrous, sometimes united behind to the substratum by a tuft of white hyphae when old ; stalk excentric, stout, up to 2 mm. long, 1 mm. diameter, of the same colour as the pileus, becoming brown, floccose, generally arising from a tuft of white or yellowish hyphae ; gills broad, ventricose, adnate or sinuato-adnate, yellow, becoming brown, margin yellow and serrate; spores yellow brown, smooth, broadly oval, 7-9 × 5-7 μ, or globose, 6-8 μ : edge of gills furnished with short clavate hairs, up to 20 μ high, 1·5 μ diameter at the base, 5 μ diameter at the apex, apex rounded. General at Peradeniya.

A specimen from Hakgala (No. 6146) has dark yellow-brown spores.

Crepidotus phaeophyllus Berk., Decades of Fungi, No. 152. Shortly stalked ; pileus flabelliform, simple, about 2 × 1 cm., or deeply lobed, up to 4 × 2 cm., convex, then almost plane, white or pallid when moist, tan coloured when dry, glabrous ; stalk excentric, almost lateral, short, white, usually arising from a tomentose patch ; gills crowded, very narrow, attenuated outwards, the longer adnate, pallid, then purple grey or purple, dark purple brown to black when dry ; spores distinctly purple in mass when moist, pale purple by transmitted light when fresh, yellow brown in herbarium specimens, oval, smooth, 6 × 4 μ. Peradeniya ; not common.

Both this and the following species are remarkable for the purple coloration of the spores under certain conditions.

Crepidotus melleus (B. & Br.) Petch ; *Aschersonia mellea* B. & Br., Fungi of Ceylon, No. 798. Sessile or shortly stalked : pileus regular, semi-elliptic, convex, or orbicular, reniform, or flabelliform, repand and undulating, up to 7 × 5 cm., white, ochraceous behind, becoming tan coloured when dry, glabrous, with slight white tomentum at the base, sometimes viscid when moist ; margin at first inrolled, appearing striate when moist ; flesh thick, white ; stalk short, up to 3 mm. long, white, longitudinally fibrillose, expanding upwards, excentric ; gills moderately crowded, broad, sometimes ventricose, decurrent or adnate, pallid, becoming purplish grey, or brown from the spores ; spores in mass dark purple brown when moist, tawny olive (Ridgway) when dry, pale purple or yellow brown by transmitted light, smooth, oval, slightly in-

equilateral, thick-walled, 6-10 × 4-8 μ; edge of gills fringed with cylindric or slightly clavate hairs, 6 μ long, 3 μ diameter. Common on decaying tree trunks, especially mango, at Peradeniya.

This is the commonest *Crepidotus* at Peradeniya, but it was not described by Berkeley and Broome. There are specimens of it, however, included in Thwaites 954 in Herb. Peradeniya.

Aschersonia mellea B. & Br. consists of small specimens of the same species.

In dry weather, the pileus may be semi-elliptic, convex, with an incurved margin, and the gills pallid, becoming purple grey. The spore print from such specimens is purple brown, and the spores by transmitted light pale purple. But when dried for the herbarium the spores are yellow-brown.

In wet weather, the pileus is repand, and flabelliform or orbicular. The gills are white or pallid, becoming brown when covered with spores. The masses of spores on the pilei, and the spore print when moist, are dark purple brown, the latter becoming tawny olive when dried on white paper. By transmitted light, the spores are yellow brown, with sometimes a faint purple tinge in the thick wall.

Crepidotus grumosopilosus B. & Br., Fungi of Ceylon, No. 239. Very shortly stalked or sessile, orbicular, up to 3 × 2·5 cm., convex, densely covered when young with coarse suberect fascicles of tawny strigae, becoming white when expanded, with scattered radial fascicles of tawny fibrils behind, silky with a few red brown points in front : stalk very short, excentric; gills ventricose, very broad, rather distant, white then brown ; spores pale yellow brown, smooth, broadly oval or subglobose, 7-10 × 5-6 μ. On dead branches, Peradeniya.

The strigose fascicles on the pileus are composed of parallel hyphae united laterally ; these hyphae are 8 μ diameter, sometimes inflated to 10 μ, constricted or not at the septa, with close-set, regular, internal annular thickenings.

Berkeley and Broome cite Thwaites 954a, *cum icone*. Thwaites 954 was a mixture, including *Crepidotus epicrocinus* B. & Br., *Crepidotus grumosopilosus* B. & Br., a species said to be a variety of *Crepidotus epicrocinus*, and another species which does not appear to have been named. It is very doubtful whether the figure is that of the specimens described by Berkeley and Broome as *Crepidotus grumosopilosus* ; it would appear to be more probably *Crepidotus truncatus*.

Crepidotus pezizula B. & Br., Fungi of Ceylon, No. 343. Sessile; usually centrally attached, at first globose, becoming pezizoid, up to 2

mm. diameter, exteriorly ashy, with a pinkish tinge, minutely tomentose, hyphae of the tomentum hyaline, minutely spinulose ; gills pale brown with a white edge, rather distant ; edge of gill bearing hairs up to 20 μ high, 2μ diameter below, hyaline, clavate, expanding to 3 μ above, or suddenly inflated into a globose head 6 μ diameter ; spores yellow brown, smooth, broadly oval, 6-9 × 4-6 μ.

This species is parallel to *Pleurotus semisupinus* B. & Br.

B. Spores warted or spinulose

Crepidotus hepatizon Berk., Decades of Fungi No. 151. Fasciculate, stalked ; pileus horizontal, at right angles to the stalk, orbicular, flabelliform, or reniform, up to 6 × 4 cm., convex, then plane or undulating, frequently proliferous at the margin when old, bay brown behind, greyish brown towards the margin, becoming ferruginous, minutely hoary ; stalk vertical, excentric, almost lateral, up to 2·5 cm. high, 5 mm. diameter, cartilaginous, compressed and lacunose, solid, glabrous, tomentose at the base, pale purplish brown ; gills ferruginous, crowded, ventricose, sinuato-decurrent ; spores yellow brown, spinulose, oval or subpyriform, 4-5 × 3 μ, or globose, 3-4 μ diameter. Apparently rare ; on rotten wood, Alagalla, July 1917 ; specimen and painting, No. 5238 in Herb. Peradeniya.

The habit of this species, with an erect stout stalk and the pileus at right angles to the stalk, is quite different from that of the other Ceylon species of *Crepidotus*.

Crepidotus velutinus Petch, n. sp. Stalked ; pileus orbicular, convex, up to 2 × 1 cm., deep yellow brown or chocolate coloured, minutely areolated, velvety, clothed with minute, erect, yellow brown, flask-shaped or conical hairs, up to 30 μ high ; stalk almost lateral, stout, 2·5 mm. diameter, fuscous, minutely velvety, with a ring of white tomentum at the base ; gills pallid, then pale brown, somewhat distant, slightly ventricose, decurrent ; spores dark brown in mass, yellow brown by transmitted light, spherical, 6-10 μ diameter, coarsely warted with large scattered warts. On a dead twig, Peradeniya ; specimen and painting, No. 4316 in Herb. Peradeniya.

Crepidotus citrinus Petch, n. sp. Shortly stalked ; pileus at first galeate, margin inrolled, then almost plane, orbicular, up to 2 × 1 cm., pale yellow or lemon yellow, pruinose, sometimes white behind, lying flat on the substratum and ultimately attached by white hyphae ; margin plicato-crenate, sometimes lobed ; stalk very short, excentric, curved, yellow, minutely tomentose ; gills rather distant, broad, edge pale and

serrate, yellow, then brownish yellow; spores yellow-brown, spherical, 5-8 μ diameter, or oval, 8-10 × 6-8 μ, covered with large blunt spines. On dead trunks, Peradeniya; type No. 3547 in Herb. Peradeniya. There is an unnamed specimen of this, Thwaites 956, in Herb. Peradeniya.

Crepidotus reversus B. & Br., Fungi of Ceylon, No. 343. Sessile or shortly stalked; pileus deep pink or red, becoming brownish red towards the margin, orbicular, convex, up to 7 × 5 mm., scurfy, with a patch of white tomentum behind and extending over the substratum, margin at first incurved; gills at first deep pink, then red brown, rather distant; cystidia on the edge of the gills oblong, sometimes inflated in the middle, up to 24 × 12 μ; spores pale ferruginous in mass, pale yellow brown by transmitted light, coarsely warted, globose, 5-7 μ diameter, or broadly oval, 6-8 × 4-6 μ. On dead branches, Peradeniya.

In dried specimens, the pileus bears minute, scattered, deep crimson granules visible under a magnification of 40 diameters. The gills bear similar but smaller granules, visible when mounted.

Berkeley and Broome's type specimen contains only very minute examples, about 1 mm. diameter.

Crepidotus epicrocinus B. & Br., Fungi of Ceylon, No. 237. Sessile, attached almost laterally by white strigae; pileus suborbicular or reniform, up to 2·5 cm. broad, convex, pale yellow, with red, more or less radiating streaks, minutely tomentose with loose, irregularly intertwined hyphae; hyphae of the tomentum thick-walled, irregularly contorted, rather closely septate; gills pale yellow, becoming ferruginous; spores yellow brown, warted, with scattered warts, spherical, 4·5-7 μ, or subglobose, 6×5 μ.

This species has not been collected again. Berkeley and Broome stated that the pileus was bright orange-chrome-yellow. The colours given above are those of the type figure.

Crepidotus truncatus Petch, n. sp. Sessile, dorsally attached; pileus elliptical, lobed behind, broadly convex, 4 × 2·5 cm., pallid, covered with a thin layer of matted fibrils, strongly tomentose and white at the point of attachment, striate from the margin over half the pileus when moist; gills not crowded, very broad (up to 1 cm.), ventricose, pallid then brownish, truncate behind, terminating at an excentric, white, tomentose area under the point of attachment; spores ochraceo-ferruginous in mass, pale yellow brown by transmitted light, globose, minutely warted (appearing smooth under a magnification of 360 diameters), 5-7 μ. On a dead branch, Peradeniya; No. 4384 in Herb. Peradeniya.

The specimens referred to by Berkeley and Broome as a variety of *epicrocinus* with a dull ferruginous pileus and broader gills has similar minutely warted spores which appear smooth under a magnification of 400 diameters, but they are larger, either spherical, 7-9 μ, or oval, 8-10 × 6-8 μ. The pileus in these specimens is sessile, dorsally attached, minutely adpressed tomentose, and the gills are broad.

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Cassia Leschenaultiana DC.

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

In his " Enumeratio Plantarum Zeylaniae " Thwaites included *Cassia Wallichiana* DC., with the description " Caule erecto, rigido, parce ramoso ; foliolis 20-25-jugis, oblongo-linearibus, aristato-mucronatis; glandula paullo supra medium petioli subsessili; pedicellis supra-axillaribus, fasciculatis; staminibus 10, valde inaequalibus " ; and added the note " Sufficiently distinguished from the preceding species (i. e. *Cassia mimosoides* L.) by the darker colour of the stems and foliage, the much larger leaves, shorter pedicel, and the different shape and position of the petiolar gland."

In Flora British India, vol. II, Baker placed *Cassia Wallichiana* as a variety of *Cassia mimosoides*. Trimen, in the Handbook of the Flora of Ceylon, adopted the same view, doubtless following the Flora British India, since he noted that he would prefer, with Thwaites, to regard it as a distinct species. He stated, " it is a very common weed about Kandy, and very distinct in appearance, having red-purple stems and blue-green foliage. "

The above is the only form of *Cassia mimosoides* which occurs at Peradeniya. At higher elevations, *e.g.*, at Hakgala, var. *auricoma* is common, but this dies out when cultivated at Peradeniya. Thwaites C. P. 1510, which is accepted as the typical plant, is also from an upcountry district.

Some years ago, seed of *Cassia mimosoides* was brought in from India for trial as a green manure, and the resulting plants were so different from the common Ceylon var. *Wallichiana* that observations were made with a view to re-establishing the latter as a species, if possible. A subsequent reference to the literature, however, showed that Indian official botanists had already decided that *Cassia mimosoides* var. *Wallichiana* was worthy of specific rank, though it was still carried on in Ceylon lists under the old varietal name.

King, in " Materials for a Flora of the Malay Peninsula " (Jour. Asiatic Soc. Bengal, LXVI, 1897), distinguished var. *Wallichiana* as *Cassia Leschenaultiana*, and gave the following differences.

Cassia mimosoides. Leaflets linear, minute, ('15 inch long) ; pedicel 1 inch, bracteolate above the middle ; pod 20-25-seeded ; stamens all fertile, alternately long and short.

Cassia Leschenaultiana. Leaflets oblong, ('4 inches long, ·15 inches wide); pedicels ·3 inches, bracteolate below middle ; pod 8-16-seeded ; stamens unequal, one to three upper often sterile.

In " Some Additional Leguminosae " (Jour. Asiatic Soc. Bengal, LXVI, pt. II. No. 2, 1897), Prain published the following note on *Cassia mimosoides.*

"Var. 2. *Wallichiana,* as to *citation,* consists of two very distinct plants, both of which, as it happens, are mixed under Wall. Cat. 5320.

" One of these is the same plant as *C. myriophylla* Wall. Cat. 5326—and is no doubt a mere variety of *C. mimosoides* distinguishable, with difficulty in many cases, by its rather longer leaflets. Like the type it has small flowers with apparently always ten stamens, and has the petiolar gland deeply embedded in the leaf stalk.

" The other is the plant described by Mr. Baker as var. *Wallichiana,* easily distinguished by its larger flowers ; in this plant often only nine, sometimes only seven, of the stamens are perfect, and the petiolar gland, though not stalked, protrudes distinctly above the upper surface of the leaf stalk. The best name for the species is *C. Leschenaultiana* DC.

"Var. 3 *auricoma* is only a more hirsute condition of the preceding. It is equivalent to *C. Macraei,* but it should not be separated as more than a variety from *C. Leschenaultiana.* "

The name to be adopted for the Ceylon plant which was considered distinct by Thwaites and Trimen is consequently *Cassia Leschenaultiana.* But what passes for *Cassia mimosoides* var. *auricoma* in Ceylon is certainly not a variety of *C. Leschenaultiana.*

Cassia Leschenaultiana (Fig. 1) is common in the neighbourhood of Peradeniya.. It is erect, with a stout stem up to 5 mm. diameter, sparingly branched above, with suberect branches, and attains a height of two-and-a-half, or sometimes three, feet. It is notable among the smaller Cassias for its intense coloration, its stems being deep purple-red and its leaves dark blue-green. The leaves appear uniformly green, whereas in *C. mimosoides* the leaves, at least when young, appear to have a pale band bordering the rachis on either side, *i. e.,* the bases of the leaflets appear to be paler than the outer parts.

In outline, the leaf of *C. Leschenaultiana* is ovate, the length of the leaflets in the same leaf varying from 10 to 16 mm. In a typical leaf, the length of the leaflets, eighteen in number, on one side, (ignoring the terminal bristle), were, beginning from the base, 11, 13, 15, 15·5, 16, 16, 16,

15·5, 15·5, 15, 15, 14, 13, 13, 12, 11, 10, 10 mm. respectively. The lowest leaflets are almost perpendicular to the rachis, while those in the middle make an angle of about 65° with it.

In *Cassia mimosoides* the leaf is parallel-sided (Fig. 2), the leaflets are about 1 mm. broad, and the acute tip is in continuation of the upper edge. In *C. Leschenaultiana*, the leaflets are up to 3 mm. broad, with a bristle-like tip about 1 mm. long, situated below the upper edge (Fig. 3).

The outstanding difference between *Cassia Leschenaultiana* and *Cassia mimosoides* is the shape of the gland of the petiole, as noted by Thwaites. The position of the gland is also different, as a rule, in the two species, though the difference is not sufficiently constant to be diagnostic. In *Cassia mimosoides*, the gland is situated so that its upper edge is at the level of the insertion of the lowest leaflets, or it may be half a millimetre below that. In *Cassia Leschenaultiana*, the gland, if only one is present, is about two millimetres below the lowest pair of leaflets, but if, as frequently happens, two glands are present, one of them is situated in the first position noted for *Cassia mimosoides*.

The gland of *Cassia mimosoides* is sessile, oval in plan, and pulvinate (Fig. 5). That of *C. Leschenaultiana* is bucket-shaped, being circular in plan, with sides gradually sloping outwards, like an inverted truncate cone, and usually slightly concave on the upper surface (Fig. 4).

In *Cassia Leschenaultiana* the sepals are yellow, with a yellow-green stripe down the centre. In general, they are reflexed when the flower opens. The petals are orange-yellow, and the two upper* have a red spot at the base. The open flower is cup-shaped, and up to 12 mm. in diameter.

The flowers are either right- or left-styled on the same plant. Only one flower of a cluster is open at one time. Sometimes all the flowers which are open at the same time on a given branch are either all right-styled or all left-styled, but more usually both right- and left-styled flowers are open on the same branch at any given time.

The number of perfect stamens varies from eight to ten, but is usually ten. A count of 118 flowers gave 103 with ten stamens, 14 with nine stamens and one staminode, and 1 with eight stamens and two staminodes. The stamens are arranged in two whorls, the five of the inner whorl being shorter that those of the outer. The five stamens of the outer whorl are not all the same length ; two are about 7 mm. long, one about 5 mm., and the remaining two about 4·5 mm. Those of the inner whorl are more approximately equal, varying in the same flower from 3 to 3·5 mm. In the right-styled flower, as seen when fully

*The terms upper and lower are used here with reference to position as seen in the expanded flower.

expanded, the lowest stamen of the outer whorl is 7 mm. long, with a purple-red anther, yellow towards the base, and a yellow filament. Proceeding clockwise round the flower, the next stamen of the outer whorl is like the first, but the third, though its coloration is the same, is only 5 mm. long. The remaining two stamens of the outer whorl are 4·5 mm. long, and have yellow anthers, tipped with purple-red, and purple-red filaments. Thus in these two, the coloration of anther and filament is reversed. The five stamens of the inner whorl are yellow, slightly tipped and streaked with purple red. When the number of perfect stamens is less than ten, one, or both, of the two lowest stamens of theinner whorl is reduced to a staminode. The staminode is, as a rule, linear, ending in a fine point, but sometimes it terminates in a short, obconic, two-pored, anther-like tip.

The arrangement of the stamens in the expanded flower is as follows. The three longer stamens of the outer whorl follow the curve of the petals. The lowest of these runs more or less alongside the pistil, diverging slightly from it, and sometimes curving at the tip so that the open end of the anther almost touches the stigma. The other two form a similar pair, diametrically opposite, so that the three stamens and the pistil together form an acute-angled cross lying obliquely across the flower (Fig. 6). The two remaining shorter stamens bend together over the centre of the flower, almost perpendicular to the pistil. Of the stamens of the inner whorl, three follow the pair of long, coloured stamens which form one side of the cross, one follows the paired stamen and pistil which form the other side, and the remaining one follows the shortest, paired, yellow stamens of the outer whorl. Alternatively, both the latter stamens of the inner whorl may follow the paired stamen and pistil.

This is evidently the flower considered under *Cassia Leschenaultiana* in Knuth, Handbuch der Blutenbiologie, III, Part I, p. 373, The diameter of the flower is there given as 12 cm., but, as it is stated that it is one of the small-flowered species, that measurement is probably an error for 12 mm. In accordance with Knuth's classification, the three longest stamens are there regarded as pollinating stamens and the other seven as catering stamens.

Cassia mimosoides

Typical *Cassia mimosoides* does not appear to be common in Ceylon. Thwaites' specimens were obtained in Pussellawa (? Uda Pussellawa) and Maturatta, and there is a specimen in Herb. Peradeniya collected by Smith at Bandarawela. I have found it growing luxuriantly in Uda Pussellawa, at an elevation of about 5000 ft., but it has not been collected at Hakgala (5600 ft.). With the exception of Pussellawa, which may

be an error for Uda Pussellawa, all these localities are outlying districts on the eastern edge of the central hills, *i. e.*, on the drier side.

In Uda Pussellawa, *Cassia mimosoides* sprawls over the ground with branches up to three feet in length, and a semi-shrubby growth in the centre of the plant, eight inches or so high. Its leaves and stems are rather pale green. Its leaves are long, narrow, and parallel-sided, up to 9 cm. long, with leaflets about 3 mm. long and 0·8 mm. broad. The consecutive leaflets, forty-seven in number, on one side of a typical leaf, from the base to the apex, measured 2·5, 3·25, 3·5, 3·75, 3·75, twenty-nine 4, 3·75, 3·75, five 3·5, 3·25, 3·25, 3, 3, 2·5, 2, to the nearest quarter millimetre.

The flower is up to 1 cm. in diameter. The sepals are red-brown down the centre, and the petals yellow, without any red spot. In most of the flowers examined, the stamens are all yellow, except for a faint reddish edge to the pores, but occasionally one of the outer whorl is slightly streaked with red. Of thirty-four flowers in which the stamens were counted all had ten stamens. Measurements on one flower showed the stamens of the outer whorl to be 5, 5, 5·5, 5, 4·5 mm. in length respectively, and those of the inner whorl, all 4 mm long. The pistil is median, and the stamens are irregularly curved, but more or less erect.

The bracts on the pedicel are distant from the flower. When in fruit, the tips of the bracts do not reach to the base of the pod, but terminate 1 to 1·5 mm. below it. The gland on the leaf stalk is situated just below the point of insertion of the lowest pair of leaflets, so that its upper edge is at the level of the point of insertion.

Cassia mimosoides var. auricoma

Cassia mimosoides var. *auricoma*, following the nomenclature of the "Flora of Ceylon," is common at Hakgala, but is a small plant there, with a procumbent stem, very slightly branched, and seldom more than eight inches long. In Uda Pussellawa, it is much larger, and has the habit and dimensions of *C. mimosoides*. It grows with the latter, but is immediately distinguishable in the field by its darker leaves and stouter stems, the latter being purple-red on the exposed side.

The leaves, as a rule, are parallel-sided, though in some cases they taper slightly towards the apex. They are shorter than those of *C. mimosoides*, usually about 5 cm. long, with leaflets 6-7 mm. long and about 1 mm. broad. The lengths of the successive leaflets, twenty-four in number, on one side of a leaf from the base upwards were 4·5, 5·5, 6, 6, 6·25, 6·5, 6·5, 6·5, 6·5, 6·5, 6·5, 6·5, 6·25, 6, 6, 6, 6, 5·5, 5·5, 5·5, 5, 4·5, 4·5 respectively. The gland on the leaf stalk is of the same shape as that of typical *C. mimosoides*, but rather larger, and it

is situated either in the same position, or with its upper edge up to half a millimetre below the point of insertion of the lowest pair of leaflets.

The flower is about 6 mm. in diameter. The sepals are red-brown down the centre, and are not reflexed. The petals are yellow, without any red spot. The stamens are usually seven in number, with from one to three staminodes. One staminode is either rudimentary, or linear, and up to 2 mm. long; its apex is usually acute, but it may be slightly expanded and compressed, and sometimes, though rarely, it resembles the other two. This staminode is situated at the lowest point of the flower, and represents the lowest stamen of the outer whorl. The other two staminodes are intermediate in character, and might be regarded as short stamens. They are about 2·5 mm. high, with a filament about half that length which expands above into an obconic, anther-like structure furnished with two apical pores. They differ from the stamens in the gradual transition upwards from filament to anther. These represent the two lowest stamens of the inner whorl. In some cases all the three staminodes are linear, in others two of them. Out of thirty-nine flowers, three had all three staminodes linear, and eight two of them linear; in sixteen flowers one staminode was wanting, and in thirteen, two were absent. As a rule, when the full complement of staminodes is not present, it is those of the inner whorl which have disappeared. The linear staminode of the outer whorl is usually present.

An examination of seventy-seven flowers gave the following results.

9 stamens	1 staminode	2	flowers
8 stamens	2 staminodes	4	,,
8 stamens	1 staminode	3	,,
7 stamens	3 staminodes	22	,,
7 stamens	2 staminodes	16	,,
7 stamens	1 staminode	18	,,
6 stamens	3 staminodes	5	,,
6 stamens	2 staminodes	5	,,
6 stamens	1 staminode	1	,,
6 stamens	no staminodes	1	,,

The most usual number of perfect stamens is thus seven.

The pistil practically median, but the flowers are nevertheless right and left-handed. Of the four stamens of the outer whorl, two are highly coloured, purple-red, while the other two are yellow or slightly streaked. The two former are situated, either both on the right, or both on the left of the flower. Of the other two, the uppermost bends forward until its tip almost touches the stigma. All the other stamens stand more or less erect from the base of the flower. The stamens of the outer whorl differ in length, and one usually appears longer than the

others, but it is not always the longest which bends towards the stigma. In one flower in which the two coloured stamens were on the right, the lengths of the stamens of the outer whorl, beginning with the lowest on the left and proceeding clockwise were 4 mm., 5 mm., 4·25 mm., 4·25 mm.; in this case the stamen which curved forward was the longest (5 mm.). In another flower of the same structure, the lengths of the stamens were 4·5, 4·5, 5, 5 mm., so that the curved stamen was one of the shorter (4·5 mm.). In another flower, with the two coloured stamens on the left, the lengths were 4·2, 3·5, 3·5, 4·0 mm.; here again, the curved stamen (No. 3) was one of the shorter.

The filaments of the outer whorl of stamens are longer than those of *Cassia Leschenaultiana*. and vary from 1·5 to 0·75 mm. in length. The stamens of the inner whorl vary from 3·25 to 2·5 mm. in length and have filaments about 0·5 mm. long.

The Ceylon form known as var. *auricoma* agrees with *Cassia mimosoides* in the shape of the gland. If therefore *Cassia Leschenaultiana* is distinguished from *C. mimosoides* on the shape of the gland, the Ceylon var. *auricoma* must be regarded as a variety of the latter. But it differs from both *Cassia mimosoides* and *Cassia Leschenaultiana*, as known in Ceylon, in the smaller average number of stamens, and in this respect it agrees with *Cassia Leschenaultiana* as described by Prain.

The Indian form cultivated at Peradeniya agreed with the Ceylon var. *auricoma*. The number of perfect stamens was usually seven, that number occuring in eighty out of one hundred and four flowers examined. Like the Ceylon var. *auricoma* it did not flourish at Peradeniya, and died out in the third generation.

Thwaites considered that the Ceylon var. *auricoma* was probably worthy of specific rank on account of the position of the gland, and of the bracts on the pedicel. He stated that var. *auricoma* (*villosula*) had the bracts nearer the base of the flower than in the typical form of *C. mimosoides*, and the gland a little below, instead of between, the lowest pair of leaflets.

The latter feature is variable in var. *auricoma*, and the upper edge of the gland may reach the point of insertion of the lowest pair of leaflets, or be 0·5 mm. below that, on specimens from the same locality.

The position of the bracts is best judged when the plant is in fruit. In *Cassia mimosoides*, the tips of the bracts, as a rule, do not reach the base of the pod, but terminate about 1 or 1·5 mm. below it. In var. *auricoma* they extend up to, or above, the base of the pod. But specimens of the latter from Hakgala have the bracts in either position on the same plant.

It would appear, therefore, that var. *auricoma* cannot be separated from *C. mimosoides* proper on either of the characters enumerated by Thwaites.

EXPLANATION OF PLATE XII.

Fig. 1. *Cassia Leschenaultiana*, × ¾.
Fig. 2. Leaf of *C. mimosoides* × ¾.
Fig. 3. Leaflets of *C. Leschenaultiana* (upper), and *C. mimosoides* (lower) × 1½.
Fig. 4. Gland of *C. Leschenaultiana*, × 4.
Fig. 5. Gland of *C. mimosoides*, × 9.
Fig. 6. The three long stamens and the pistil of *C. Leschenaultiana*, × 4.

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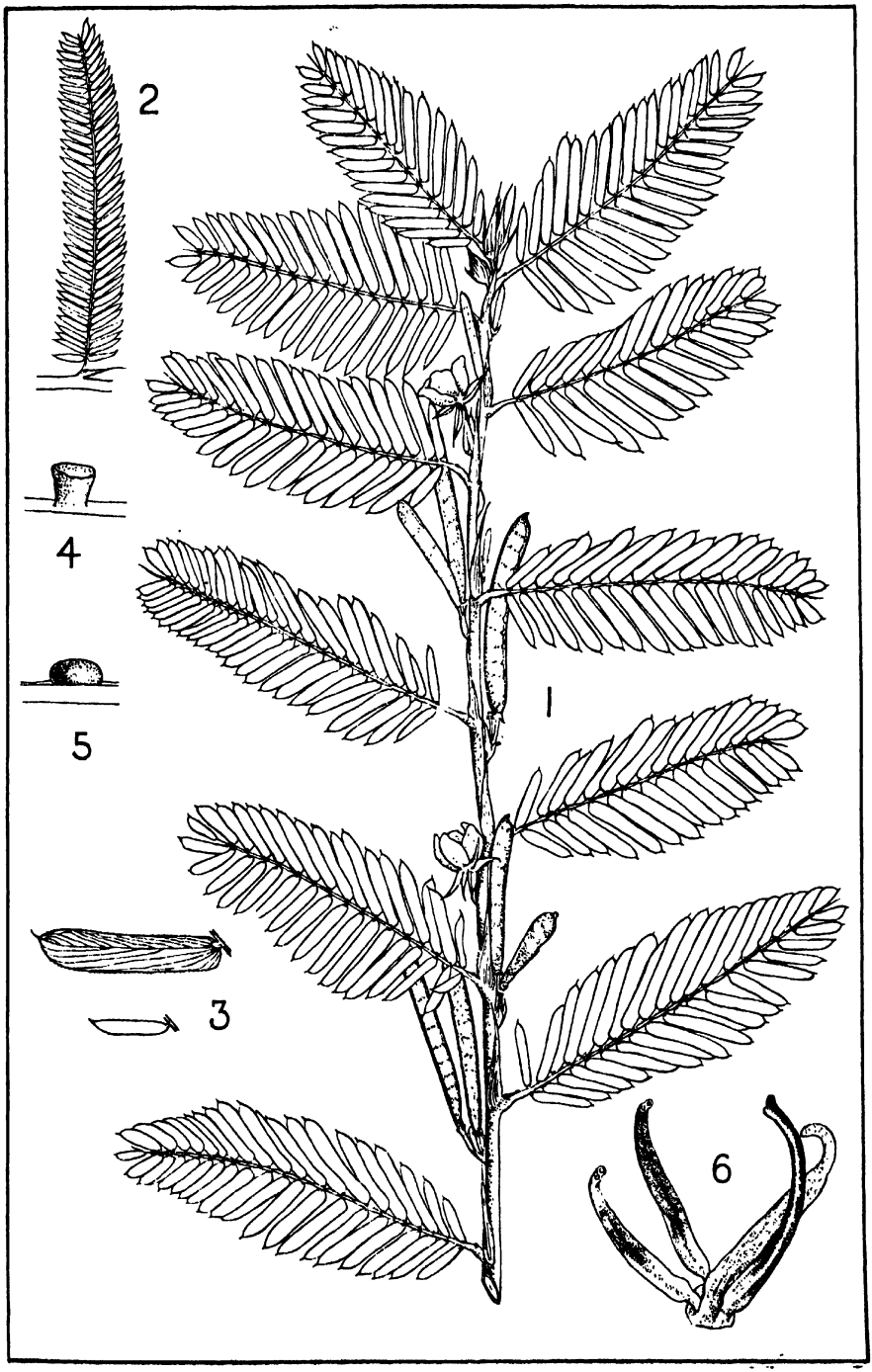
2
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Meristic Variation in Loranthus

BY

T. Petch, B.A., B Sc.

A few years ago, a specimen of *Loranthus ligulatus* Thw., sent in for identification from the Mannar district, was found to bear several flowers with six petals (corolla segments) in place of the normal five. Subsequently other flowers of this species, and those of other species of *Loranthus*, were examined in order to determine to what extent meristic variation occurred in the flowers of this genus in Ceylon.

Loranthus cuneatus Heyne

This is a common species in Ceylon in both the wet and the dry regions, and occurs also in South India. Specimens were collected at Peradeniya in March-April 1923, and examined by Mr. E. J. Livera.

5 petals, 5 stamens	1171
6 petals, 6 stamens	1

Loranthus ligulatus Thw.

This is a rare Ceylon endemic, which occurs in the northern part of the dry zone, chiefly on *Salvadora*. Flowers were collected from a number of plants at Mannar in February, 1923. Counts of the petals and stamens gave the following results.—

4 petals, 4 stamens	3	flowers
5 petals, 5 stamens	1324	,,
5 petals, 6 stamens	1	,,
6 petals, 5 stamens	1	,,
6 petals, 6 stamens	12	,,

Out of a total of 1341 flowers, 17, or 1·27 per cent., differed from the normal. The variation was chiefly in the direction of an increase in the number of parts.

Loranthus loniceroides L.

This species occurs in Ceylon and South India Flowers were collected at Hakgala in February-March, 1922. They were consequently the up-country variety, which, as noted by Trimen, may be a different species from the plant named by Linnaeus which Hermann collected

in the low-country. I have not seen low-country specimens. The Hakgala form is notable for the thickened lobes of the corolla, which in bud form a hard, bluish grey or slate-coloured, conical tip. The flowers gathered from eight plants gave the following numbers,—

5 petals, 5 stamens	2	flowers
6 petals, 6 stamens,	1045	,,

The variation in this species is very small, and only abnormal flowers with a reduced number of parts were found.

Loranthus longiflorus Desrouss.

This species occurs in Ceylon, India, and Malaya. Flowers were collected at Mannar (near sea level, dry zone) in February 1923, at Peradeniya (1600 ft) during December 1921, from a plant on Pumelo, and at Hakgala (5600 ft) in February-March, 1922, from seven plants. The Hakgala form is assigned to var. *amplexifolius*. The count of the Mannar specimens was made by Mr. E. J. Livera.

	Mannar	Peradeniya	Hakgala
3 petals, 3 stamens	—	2	—
4 petals, 4 stamens	—	4	5
5 petals, 5 stamens	399	492	535
6 petals, 6 stamens	—	1	2

The variation is principally in the direction of a reduction of parts. The Mannar specimens showed no variation, the Peradeniya specimens 1·4 per cent. and the Hakgala specimens 1·3 per cent. The variation of the total number was slightly below 1 per cent.

Loranthus neelgherrensis W. & A.

This species occurs in South India and Ceylon, and is common in the latter country up to an elevation of 7000 feet. It is very common on fruit trees at Peradeniya. Specimens were collected at Peradeniya on Pumelo and on Mango in December 1921, on tea, cacao, etc., in the same locality in March 1923, and on Acacia at Hakgala in February-March, 1922. Counts of the 1923 Peradeniya specimens were made by Mr. E. J. Livera.

	Peradeniya 1921.	Peradeniya 1923.	Hakgala.
3 petals, 3 stamens	2	—	—
4 petals, 4 stamens	23	5	11
4 petals, 5 stamens	1	—	—
5 petals, 5 stamens	1043	333	753
5 petals, 6 stamens	1	—	—
6 petals, 5 stamens	1	—	1
6 petals 6 stamens,	5	—	2

The variation is again principally a reduction. At Peradeniya, 3·07 per cent. of the first collection and 1·8 per cent. of the second, and at Hakgala 1·83 per cent., of the flowers showed variation. The combined results give a percentage of 2·28. 7·7 per cent. of the abnormal flowers showed unequal variation of the petals and stamens.

Loranthus sclerophyllus Thwaites

A Ceylon endemic. Specimens were gathered at Hakgala in February-March 1922, from three plants.

5 petals, 5 stamens	840
6 petals, 5 stamens	1
6 petals, 6 stamens	18
7 petals, 7 stamens	1

The variation, as shown by these specimens, is solely in the direction of an increase of parts. 2·34 per cent. of the flowers showed variation.

Loranthus suborbicularis Thw.

A Ceylon endemic. Specimens were collected from several plants on *Rhododendron* at Hakgala in February-March, 1922, and in September 1923.

4 petals, 4 stamens	2
5 petals, 5 stamens	927

Loranthus tomentosus Heyne var. **incanus** Trimen.

Specimens were gathered at Hakgala in February-March, 1922.

4 petals, 4 stamens	24
5 petals, 5 stamens	653
6 petals, 6 stamens	5

3·96 per cent. of the flowers were abnormal. The variation was chiefly in the direction of a reduction of parts.

The variation in the flowers of *Loranthus* proved to be much smaller than had been expected. Three species, *L. cuneatus*, *L. loniceroides*, and *L. suborbicularis*, showed scarcely any modification from the normal in number of parts. The greatest variation occurred in *L. tomentosus* var. *incanus*, in which the abnormal flowers amounted to 3·96 per cent. *L. sclerophyllus* and *L. neelgherrensis* gave 2·34 and 2·28 per cent. respectively, *L. ligulatus* 1·27 per cent., and *L. longiflorus* slightly less than 1 per cent.

In general, the number of petals and stamens remained equal. Unequal numbers of stamens and petals were found only in 7 flowers out of a total of 10292.

Variation consisted principally of a reduction of parts. But in *L. ligulatus* the majority of the abnormal flowers, and in *L. sclerophyllus* all the abnormal flowers, had an increased number of parts.

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The Corm of Gloriosa superba

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE AND ONE TEXT FIGURE

One of the most striking of the Ceylon herbaceous plants is the liliaceous climber, *Gloriosa superba*, the Sinhalese Niyangala. It owes its scientific name to the eulogies bestowed upon it by the early botanists, Hermann styling it *Lilium superbum* and Burmann, *Methonica gloriosa*. Hence Linnaeus combined the two epithets in *Gloriosa superba*. The Sinhalese name is probably derived from Naga, a cobra, and ala, a yam, the corm being frequently employed in village cases of poisoning.

Apart from its beauty, which appeals even to the most casual visitor, *Gloriosa superba* offers many points of interest to the botanist, *e.g.*, its peculiar corm, its leaf tendrils, the colour changes of its remarkably reflexed perianth, the movement of the style relative to the stamens, etc. The present account deals with the first of these, and is the consequence of superintending the collection of over three hundredweights of corms for the purpose of pharmacological investigation.

Linnaeus, in Flora Zeylanica, described the corm as " Radix carnosa simplex, ad angulum rectum flexa," a more accurate description than those of later writers.

In Flora British India *Gloriosa superba* is said to have a rootstock consisting of a chain of fleshy arched tubers, budding from the convexity above. This suggests that the tubers are arched in a vertical plane, and that several occur in succession, like the customary representation of the sea serpent.

The description in the Handbook of the Flora of Ceylon is evidently a combination of that in Flora British India and manuscript notes by Trimen. It reads as follows,—" Rootstock of arched, solid, fleshy, white cylindric corms, 6-12 inches long, 1-1½ inches diameter, pointed at each end, bifurcately branched (or V-shaped), producing a new joint at the end of each branch." " Stem given off from the angle of the young corms (biennial, Roxb.)." The last statement is somewhat ambiguous ; it is the corm which Roxburgh said was biennial,

The corm is composed of two arms which in the large majority are practically at right angles to one another. Cases do occur in which the angle is greater or less than a right angle, but these variations are apparently caused by obstructions in the soil. The arms are sub-cylindric, tapering to a blunt point at the tip, and may, in large specimens, be somewhat contracted towards the junction. In general one arm is much longer than the other, for example, 10.5 and 5.5 cms. respectively, but in very large corms, the two arms approach equality. The largest corm I have seen had arms 18.5 and 18 cms. long respectively. In general shape, the corm recalls the conventional figure of a boomerang, but the two arms are, unless distorted by stones, etc., in the soil, practically at right angles. The corm lies horizontally in the ground, with the two arms in the same horizontal plane, and the stem is attached to the upper surface of the corm at the junction of the arms (fig. 1).

Variation in the shape of the corm occurs especially in small specimens. Small plants which grow to a height of two inches or so above the ground and then die down, have globose corms about the size of a pea. Others, somewhat larger, may have simple conical corms, about 2 cms. long, lying horizontally in the soil (fig. 2). But when a corm has attained a length of about 4 cms., it usually exhibits the normal rectangular shape, with one long and one short arm. It is probable that the very small plants are not far removed from the seedling stage.

The corm is white at first, but soon acquires a brown, separable skin. In general, when the corm is dug up, it is brown, except near the tips of the arms.

Interest was aroused by the peculiar shape of the corm, and the attachment of the stem in a position where one would not have expected to find a growing point; and consequently observations were made to determine how the new corm arose from its predecessors. This point is immediately decided on digging up young plants, in which the stem has attained a height of about a foot. It is then seen that the new corm arises at the tip of one of the arms of the old corm, the apex of the angle of the new corm being united to the tip of the arm of the old corm. From small corms, a new corm arises, as a rule, from the tip of one arm only. The larger corms may produce a new corm at the tip of each arm (fig. 1). But when only one new corm grows from the old one, it is invariably at the end of the longer arm; while if the old corm produces a new corm at each end, that at the end of the longer arm develops first. The longer arm is physiologically and morphologically the older.

Thus, the "rootstock" of *Gloriosa*, when the plant is young, consists of an old corm, and a new corm united to it, the aerial stem being attached to the latter; or, at the most, of an old corm, with a new corm

at each end, each of the latter bearing an aerial stem. As the aerial parts of the plant grow larger the reserve food of the old corm is consumed or transferred, and the corm decays, so that finally one, or in the second of the cases noted above, two, plants are left, each attached to an isolated corm. The parent plant cannot give rise, vegetatively, to more than two plants in one generation. All these corms lie in the same horizontal plane, except under abnormal circumstances which will be detailed later.

A variation of the foregoing sometimes occurs in nature, and may be induced by appropriate treatment. The stem of *Gloriosa* remains unbranched for a considerable distance from the base. If the apical growing point of a leafy aerial stem, up to at least two feet high, is destroyed, it is unable to produce lateral buds and consequently does not grow further, remaining in that condition for a long time and ultimately dying down. This frequently happens in nature, the upper part of the stem being destroyed by caterpillars or eaten off by animals. In general the new corm continues to develop, and all the reserve material of the old corm passes over into the new one, the latter then remaining dormant until the next season, when it sends up a new stem. In some cases, however, when the stem has been bitten off at ground level, the new corm sends up a new stem, with the consequent formation of another corm, before the original corm is exhausted. In that case, three generations of corms may be found connected with one another (Fig.3). This may result from transplanting young plants, owing to the death of the original aerial stem. The aerial part of *Gloriosa*, in my experience, rarely survives transplanting, in spite of the fact that it arises from a corm.

The position of the new corm relatively to the old one is subject to two rules, (1) the longer arm of the new corm lies in the same straight line as the arm of the old corm from which it arose, and (2), the shorter arm of the new corm points in the direction opposite to that of the other arm of the old corm.

Take for example the case of a corm, of which the longer arm (A) points to the north and the shorter arm (B) to the west. The new corm which arises at the tip of (A) will have its longer arm pointing to the north and its shorter arm to the east. If a new corm also develops from the tip of (B) this will have its longer arm pointing to the west and its shorter arm to the south. If this be plotted out on paper, it will be seen that, if the arms of the corms were equal, and a new corm of the same dimensions developed at the end of each arm, then in the fourth generation there would be eight corms, four widely separated, and the other four in pairs, each pair forming a square with their apices in contact. However, as already stated, neither of these conditions is fulfilled. The

arms of the corm are usually unequal in length, and a new corm may arise only at the end of the longer arm ; or if two new corms develop that at the end of the shorter arm is later and smaller.

The development of the new corm is easily followed in the laboratory. A plant is dug up and the stem cut off, or the stem may be allowed to die naturally. The corm is then left lying on the table. If the corm is white, *i.e.*, if it has not yet developed its outer, brown, separable skin, the latter is soon formed under these conditions. In a short time, sometimes within a few days, a line or groove will be noted at the tip of the longer arm, demarcating a more or less triangular area,extending backwards from the tip on the upper surface of the corm, like a finger nail. Beneath this area lies the tissue containing the new bud, which consists of a small thick scale turned backwards from the tip of the arm. If the apex of the corm is more or less acute, this scale lies on the upper surface ; if however it is very obtuse, the scale is situated more vertically at the end of the arm and does not extend so far over the upper surface. This scale is not evident macroscopically on the fresh corm, but under the conditions stated it begins to increase in thickness and is consequently indicated by the raising of the outer brown coat. The outer coat is subsequently ruptured, and the scale becomes erect, increasing in thickness so that both surfaces become convex, and growing downwards below its point of attachment to the corm (Fig. 5).

Roots now begin to develop at the base of the scale, but unless supplied with water they usually remain short, 1-2 mm. long, or they may fail to break through the initial root prominences. From this point, the further course of development varies. The scale may rupture at the apex, and a shoot grow out to a length of six or eight inches, the scale forming the first scale leaf ; or nothing further may occur except an increased thickening of the scale, often accompanied by a bifurcation at the apex. Fig. 6 shows a specimen in which the scale has thickened, but the shoot is emerging through the convex upper surface ; while Fig. 7 shows a case in which the scale has thickened and bifurcated. Plants may remain dormant in this condition. If, however, the corm is placed so that its developing roots dip into water, the roots lengthen, and the shoot bursts through the apex of the scale and develops normally. Plants may be maintained in water culture in this way for several months ; they have been grown to a length of 210 cms. in water culture in the laboratory, but have not flowered under these conditions.

It is to be noted that the first stages of development are obtained by allowing the corm to dry ; and a shoot may be produced, up to 8 inches high, while the corm is lying on the laboratory table. The roots, however, remain rudimentary under these conditions. To cause the

elongation of the roots, and to ensure the development of the shoot, water must be supplied after the roots appear. If that is not done, the new plant may become dormant.

Fig. 8 shows a vertical longitudinal section, not quite median, through the tip of the corm after the scale has become evident. The tip in this case is obtuse, and the scale which contains the bud is vertical. The outer brown coat has been removed, but the scale is not superficial, being covered by a thin layer which is attached immediately below the scale and is continued over to the upper surface where it ends in a free edge, not shown in the figure.

Fig. 9 shows the corresponding section in a similar corm in an older stage. The outer brown skin is wanting, as is also the layer which covered the scale in the earlier stage. The scale now consists of a series of closed sheaths, enclosing the bud, and the outermost of these sheaths is continuous with a mass of parenchyma in the angle between the scale and the corm; which in turn is continuous with a thin layer split off from the upper surface of the corm. The line of cleavage of this latter layer does not proceed far, and in the specimen in question the layer does not end in a free edge.

Both the foregoing sections were taken from examples developed naturally, not in the laboratory.

When the scale thickens abnormally, as already described, under laboratory conditions, the thickening is due to a development of parenchymous tissue on the inner side of the scale.

Several sheathing scale leaves are produced in succession before the normal leaves appear. In this, the "spear" stage, the young plant has a slightly swollen base. If the bud scale was more or less vertical, the young plant is attached laterally, a little distance above its roots, to the apex of the corm (fig. 10); but if the scale was situated more horizontally along the upper surface of the old corm, the new plant is perched on the top of the latter (fig. 11). By the time the normal leaves appear, or sometimes before that, the swollen base begins to bulge out on the side opposite the point of attachment to the parent corm. This swelling is the first indication of the development of the longer arm of the new corm, and growth continues uniformly in that direction, *i.e.*, in the same straight line as the longer arm of the parent corm (Fig. 11). Some time later, a similar swelling occurs at the base of the stem, in the same horizontal plane as the former, but in a direction at right angles to it, and by further growth in this direction the shorter arm of the new corm is formed.

Judging from plants dug up at various stages, the development of the corm is not completed until the aerial parts of the plants are

about to die down. On corms obtained from plants which are beginning to die, the distal end of at least the shorter arm may be still white. But the formation of the new corm begins soon after the appearance of the aerial stem.

The initial bud of the new plant is evidently part of the parent corm. By the time it has become erect, it appears quite distinct from the old corm ; and by further development of its base, the latter becomes the new corm, so that the stem appears to arise from the new corm. Thus, when a plant is dug up and found to have only a single corm, the latter is the new corm in process of formation, not the corm from which the stem originally arose.

The two branches of the new corm and the aerial stem lie along three lines at right angles to one another. This ternate branching is repeated in the aerial stem, but the branches of the stem do not, as a rule, develop equally, and the angles between the branches are variable.

It will be evident that the corm of *Gloriosa* does not produce a bud "from the convexity," *i.e.* from the angle of the corm, but that, conversely, the bud produces the corm at its base. The bud arises from the apex of the arm of the old corm ; and the corm to which the stem is attached is the new corm in course of formation by the enlargement of the base of the stem. The two arms of the new corm may be regarded as two lateral branches.

Corms left drying on the laboratory table start into growth much more rapidly than those planted in the open or in pots. Two plants were dug up on December 20th, 1921. Plant A had a partially collapsed old corm, with arms 9 and 3.5 cms. long respectively, and a new corm, with arms 12 and 6 cm., from which a stem 60 cms. high arose: the new corm was still white and the plant had not approached the flowering stage. Plant B had a partially collapsed old corm, with arms 4.5 and 3 cms. long respectively, and a new corm, with arms 6.5. and 4.5 cm., from which arose a stem 26 cms. high ; this corm was also white and the plant still younger than the previous one. The old corm and the aerial stem were removed in both cases, and the new corm of A was planted in a pot exposed to the weather, while that of B was left lying on the table. On January 26th, 1922, B was developing a bud, and on February 9th, this was erect and the roots were just visible. On February 18th, it was placed so that its rudimentary roots dipped into water, and in three days these grew to a length of 1 cm. A month later (March 17th) the new shoot was 50 cms. high and by April 7th both arms of a new corm were well-developed. A, however, did not produce a new shoot until the first week in September.

Three small plants with new corms about 5 cms. long were planted in a bed on May 12th, 1921. The aerial stems of all three died shortly afterwards. A new shoot appeared from one plant on September 11th, but was eaten off a few days later. A second plant produced a shoot on November 7th, and the same fate befell this after it had attained a height of about six inches. Nothing further appeared until June 1922 when all three plants sent up new shoots. Thus, the first plant produced a shoot from the original corm planted in four months, and another from a corm subsequently developed in nine months. The second plant produced shoots from similar corms in six and seven months respectively. But the third did not produce a shoot from the original corm until after the expiration of thirteen months. Meanwhile a similar corm, dug up on June 12, 1921, and left on the laboratory table, had formed a new bud and was developing roots by July 29th, 1921.

A large corm, with arms 18.5 and 18 cms. long respectively, was dug up on May 28th, 1921. The plant had flowered and was dying. The corm was left on the table, and on May 30th, it was noted that one tip was splitting, *i.e.* the terminal scale or bud was beginning to grow. The significance of this separation was not realised at the time, and the corm was immediately placed, half embedded in soil, in a pot which was covered with a sheet of glass, the soil being kept moist. No further growth occurred up to February 23rd, 1922. Owing to my absence from February 23rd to March 13th, the soil became dry; it was watered again on the latter date. On March 27th, the scale at the tip of the longer arm was becoming erect, and on April 6th, it was developing roots. This tip was cut off on April 14th. On April 27th, the scale at the tip of the other arm became erect, and had developed roots by May 8th. On the latter date, this second growing point was cut off. The corm was then planted in a pot which was left exposed to the weather. In July 1923, it was dug up and found to be sound, but in March 1924 half the shorter arm was found to have decayed. The decayed part was cut off and the corm replanted. By July 1924, no further decay occurred, but by December 1924, the shorter arm had decayed completely and the rot had extended round the bend to the longer arm. During this period of two and a half years, there was no production of new buds.

There is no doubt that in the last case cited, the corm, if it had not been potted and watered, would have developed an erect bud and initial roots in about a month, and if it had then been supplied with water further development of the roots and shoot would have followed immediately. But planting the corm and watering it when the scale first began to separate stopped development for nearly a year.

It would not be correct to suppose that under natural conditions the corm must undergo a period of drying before it can produce a new shoot. New plants certainly appear when the rains begin in April, after the dry season, January to March. But they also spring up at any time from April to December, and during that period the corms have little chance of drying in the Peradeniya district.

The " forcing " of a corm by leaving it to dry has been done in all months from May to January. It has succeeded equally well with corms from plants which have flowered and are dying down, from large plants which have not flowered, and from small plants six inches high.

The development of shoots, etc., from bulbs or corms without the addition of water is a well-known phenomenon. Jost (Plant Physiology, English edition, p. 162) wrote " It is well-known, for instance, that potato tubers are able to develop shoots if not in too dry an atmosphere owing to their possessing a store of water, and that some bulbs and tubers may give rise to shoots bearing flowers, without any absorption of water being observable. Medicus (1803) noted this in the case of *Veltheimia capensis* ; Hildebrand (1884) drew attention to the same fact in *Oxalis lasiandra* ; and recently *Sauromatum guttatum* has been put on the market as a curiosity in consequence of its power of forming flowers in the complete absence of water, after being heated."

Fig 1. Plants Developed from Bulbils of *Crinum Moorei.*

The bulbils from the inflorescence of *Crinum Moorei* will produce a plant with bulb, shoot, and roots, while lying on the table in the laboratory. Text figure 1 shows three such plants, attached to the shrivelled bulbils. These were brought down from Hakgala (5,600 ft.), on September 21st, and left on the table in the laboratory at Peradeniya (1,600 ft.). The photograph was taken on December 9th. The bulbs were then up to 3 cms. in diameter. The longest shoot was 3.5 cm. long,

but had withered at the top, while the roots, up to 3 cm. long, had similarly withered. One example bore five withered roots, and was producing seven new ones.

It will have been noted that in the cases recorded of growth from the corms of *Gloriosa* in the laboratory the new bud begins to develop after a period varying from a few days to about a month. The dormant period of the corm is shortened or abolished. Shortening of the dormant period in potato tubers was experimentally induced by Schmid (Ber. d. Bot. Gesell.. XIX, p. 76) who kept recently-harvested potatoes half embedded in sand in a greenhouse from October 21st, and obtained shoots with leaves by November 8th. Schmid concluded that the essential conditions for this forcing were a high temperature and ample aeration. His results however are not comparable with those obtained with *Gloriosa*, as the tubers were watered with a nutrient solution and evaporation was prevented by covering the pots with a glass plate.

Exposure to light does not appear to have any influence on this forcing of the corms. In the case of the large corm which was half embedded in soil after the initial separation of the scale, no further growth occurred for ten months, although it was exposed to light almost equally with the corms which were lying on the table. Similarly, this corm was subject to the same temperature as the others.

Pfeffer (Pflanzenphysiologie, III, p. 267) stated, "A temporary withering appears to favour the sprouting of bulbs of hyacinth and tulip, and corms of Crocus. It has not been definitely determined how far this depends upon the degree and duration of drying." It would appear that the present case is similar, and that this forcing of the corms of *Gloriosa* is to be attributed to the drying.

There is very little evidence of change in the contents of the corm at the time the new shoot and roots appear. Most of the cells near the growing point are then filled with starch grains, and there is a remarkable absence of any signs of corrosion. The drying does not induce a general conversion of the starch.

Gloriosa superba, for its full development, requires low shrubs over which it can climb. It is consequently associated with scrub jungle, or occurs along the jungle edge, or along roadsides, or is found as a weed in shrubberies. But it comes rather as a surprise to find that at Peradeniya it is a common constituent of the flora of open pasture land. Dozens of plants may be found among the grass in such situations. These plants remain small, not more than four inches or so high. Of course they never flower, but are propagated by the corms, which are

usually small, not more than about 5 cms. long. Many of these plants are eaten down, but whether by cattle or hares has not been ascertained. If they are eaten by cattle, the latter do not suffer in any way. It may be that the aerial parts are not poisonous, but the distribution of the poison in the plant does not appear to have been determined. In the case previously referred to (p.249), in which two young plants were eaten down, these were growing within a barbed wire fence and were not accessible to cattle.

Plants growing in grass at Peradeniya usually have their corms situated at a depth of about two inches. Those which spring up in a neighbouring tea estate where the ground is kept free from weeds, but the soil is compact, have their corms at the same depth. But in flower beds and shrubberies, where the soil is loose and periodically forked, the corms are at a depth of about seven inches. If a young plant is dug up and planted in a pot, the aerial stem, as already stated, usually dies, but the new corm continues to develop from the old corm. When the young plant has been taken from grass land, and planted at its normal depth in a pot, the part of the new corm which is subsequently developed turns vertically downwards.

Figure 3 is a lateral view of such an example. The corm to the right is the oldest corm, of which only part is shown. The plant was dug up when the new corm had grown to half its length, and planted in a pot. The aerial stem died, but the new corm continued to grow and both arms turned downwards. This corm subsequently produced new stems and corms at the ends of its arms, and these new corms were again directed downwards. Only one of the daughter corms of the third generation is shown in figure 3. Both are seen in figure 4, which is an end view of the same series of corms.

Conversely, if a corm is planted too deep, the new corm will be directed upwards (fig. 12).

When a plant left lying on the table develops a new corm, the latter points downwards. In the case of the plant grown to a length of 210 cm. in the laboratory, with only the roots originally immersed in water, both arms of the new corm turned vertically downwards into the water, the longer eventually reaching to the bottom of the beaker. The beaker was not darkened, but during the greater part of the period of formation of the corm it was beneath a table near a window and consequently in a weak light.

The foregoing facts indicate that the corms of *Gloriosa* grow at a definite level which varies with different soils. This point has not been

investigated further. The result obtained in water culture would appear to show that this level does not depend solely on the level of the water table.

The Flora of Ceylon states that *Gloriosa* flowers from September to January. At Peradeniya, January, February, and March are dry months, with an average rainfall of 3·74, 1·55, and 4·68 inches respectively. April is the month of the " Little Monsoon, " with an average rainfall of 8·45 inches. May is drier (5·91 inches), but June and July are the rainy months of the south-west monsoon, with rainfalls of 11·03 and 8.31 inches respectively. The rainfall decreases again in August and September (6·04 and 6·72 inches), and increases again, owing to the rains of the north-east monsoon, during October, November, and December which have average rainfalls of 13·54, 10·41, and 8·56 inches.

At Peradeniya, plants of *Gloriosa* begin to spring up during the showery period at the end of March, and new ones continue to appear at any time until the following January. But the majority of the larger plants first appear above ground in August-September. In general, February and the first half of March is the period during which no new plants arise.

Plants of medium size may be found in flower at Peradeniya and in the wet low-country from June onwards, though the main flowering period is, as stated in the Flora of Ceylon, September to January. But plants which spring up late in the year will continue in flower during February and March, while those which appear in December and January will persist through the dry season and bloom in April and May. In the wet zone of Ceylon, *Gloriosa* may be found in flower, as a rule, throughout the year. The flowering season is prolonged because of the successive appearance of new plants at all times except during the driest months.

It is possible that in the dry zone of Ceylon, where the rainfall is limited principally to the north-east monsoon period, October-January, *Gloriosa* may exhibit a more definite general periodicity. The plant, however, is common in the wet zone, and cannot be classed as a dry zone species.

Flowering is dependent upon the size of the plant. As a rule, plants do not flower unless they attain a length of six feet or so. The size of the plant depends upon the size of the corm.

Small corms produce small plants which die down in a few months without flowering. Some of the small plants in open grass land are only two to three inches high, with a stem about a millimetre in diameter, and bear about half a dozen leaves crowded together. In these the spear barely appears, or does not appear, above ground. Others

may attain a height of a foot, with a stem about 2 mm. in diameter, bearing up to twenty leaves more widely separated. These small plants may die down in June and be succeeded by others from the daughter corms in September. As a rule, they are absent in the dry season. But plants of the same size in flower beds or on bare ground will persist through the dry season, though exposed to full sunlight. In 1922, small plants which appeared in December on bare ground near the new laboratories at Peradeniya survived the dry season of 1923, although no rain fell between January 26th and March 4th.

Large corms give rise to plants which may attain a length of 20 feet. The spear stage may be 2 ft. or 2 ft. 6 in. high, the upper part bearing rudimentary leaves, and the stem 8 mm. in diameter. The growth of these plants is rapid ; a plant which sprang up on July 28th had attained a length of 12 feet and had begun to flower on September 10th. These plants die after flowering, independently of the season when the flowering occurs ; that just referred to died in the first week in November.

It might, perhaps, have been expected that the dormant period of the corm would coincide with the dry season, and would be a short one of two or three months. For very small corms this would appear to be the case, as these small plants spring up in abundance at the commencement of the rains. But for the majority of the plants, especially the larger flowering examples, this does not hold good. Their dormant period includes, in general, the dry season, or the latter part of it, but it also extends through the rains of the south-west monsoon, and the majority of the new plants spring up in August-September, in the moderately wet period between the rainy months of the two monsoons. Moreover, some plants will retain their aerial stems through the dry season and flower when the rains begin.

In one case, a new corm planted in December produced a new shoot in September of the following year. A large plant which died, after flowering, in the middle of March, was succeeded by another in the middle of August. Another, of medium size, which died, after flowering, at the end of April, was followed by its successor on October 15th. A number of plants, grown together in the Botanic Gardens, which died, after flowering, in November-March, left corms which produced new plants in the following July-September. The period of dormancy of the corm is not necessarily related to the dry weather (January-March), and new plants do not all spring up together at the beginning of the rainy season.

In *Gloriosa*, the vegetative period, *i.e.* the formation of a long leafy stem, precedes the flowering period, in contrast to such species

as the crocus, in which the leaves and flowers appear almost simultaneously. The formation of the new corm begins almost as soon as the first leaves appear, and in some instances the new corm exceeds the old one in size before the stem is a foot high, though only when the stem has developed leaves. In cases already cited, one plant had arisen from an old corm, the arms of which were 9 and 3·5 cms. long respectively, and had developed a new corm, with arms 12 and 6 cms., by the time the stem was two feet high ; and another had arisen from an old corm, with arms 4·5 and 3 cms., and had developed a new corm with arms 6.5 and 4·5 cm., when the stem was ten inches high. Both these plants were about six weeks old and had few leaves. In such cases the new corm has evidently been formed chiefly at the expense of the reserve material in the old one. But other examples show a different relation ; in another case, a plant about ten weeks old which had originated from a corm the arms of which were 12 and 9 cm. in length, had developed a stem 7 ft. in length while the arms of the new corm were only 7 and 5 cm. respectively. In the latter case the plant bore many leaves, and the old corm was not collapsed. The development of the stem in this case was in advance of that of the corm.

It is known that if a plant is cut down at ground level at an early stage, the new corm continues to develop, and the reserve food of the old corm is transferred to the new one. Also, the small plants which cease aerial growth after producing a stem about a foot high do not exhaust the old corm in the formation of leaves and stem, and the excess reserve food is presumably similarly transferred to the new corm. In any case, the fact that the corms of these small plants increase in size in successive generations is evidence of a gain of reserve material in each generation, and that, under average conditions, cannot be obtained without the transfer of an excess on the formation of each new corm.

As an organ of propagation, the corm of *Gloriosa* is not very efficient, as at most only two daughter corms can be produced.

The presence of a corm in *Gloriosa* may be regarded to some extent as an adaptation to habitat. The plant grows normally among bushes or scrub jungle, over which it climbs. The corm enables it to produce a long initial shoot rapidly, and it thereby grows quickly through the bushes into a position in which its leaves will not be subject to excessive shading. But this is only applicable in the case of the larger corms.

It has already been shown that the period of dormancy of the corm is not confined to the dry season. Moreover, the aerial parts of the plant can survive the dry season over a great part of its range. Consequently it does not appear that the corm of *Gloriosa* can be regarded as an adaptation to climate.

Small corms produce plants which remain small and do not flower. It is only by the accumulation of reserve food through successive vegetative generations that the corms increase in size until they are large enough to produce flowering plants. The corm of *Gloriosa* is not necessarily able to produce a flowering stem, and the individual corm does not increase in size until it can. Increase in size of the corms (and the plants) comes with successive new corms, until finally a size is reached which will enable the next aerial shoot to flower. When that stage has been attained, the majority of the succeeding corms should, under normal conditions, give rise to flowering stems,—not all, because the corm, if any, produced at the end of the shorter arm may be too small.

It may be suggested that this function of accumulating the excess reserve food of successive (vegetative) generations is the fundamental explanation of the existence of corms in general, the adaptation to the seasons which is so evident in temperate climates being secondary.

It is not clear why the plants which develop from small corms should remain small. The size of the corm will govern the size of the terminal bud, and consequently the diameter of the aerial stem. The diameter of the stem increases upwards from the corm, but the stem does not undergo any subsequent thickening. Consequently the plant cannot develop a stouter stem. But there does not appear to be any obvious reason why the stem should not increase further in length, utilising the remainder of the reserve material in the corm. The suggestion that the growth of the aerial stem ceases when the new corm begins to develop is not supported by the observations which have been made in the laboratory and in the field.

The foregoing account is based chiefly on field observations, time not being available for detailed experiment. It will be evident that *Gloriosa* offers a wide field for physiological experiment, particularly as regards the relationship of the old and the new corm, and the aerial parts of the plant.

EXPLANATION OF PLATE XIII

(*Old Corm Marked* X)

Fig. 1. An old corm, producing a daughter corm at each end; x 2/3.

Fig. 2. A small corm, producing a new corm at each end; nat. size.

Fig. 3. Lateral view of three successive corms, the third and half the second being formed after transplanting and directed downwards because the old corm was not planted deep enough; nat. size.

Fig. 4. End view of the same series of corms ; nat. size.

Fig. 5. Apex of old corm, showing bud scale ; x 2.

Fig. 6. Apex of old corm, with bud scale abnormally thickened, the shoot breaking through on the convex surface : developed by drying ; nat. size.

Fig. 7. Apex of old corm, with bifurcated scale ; developed by drying ; nat. size.

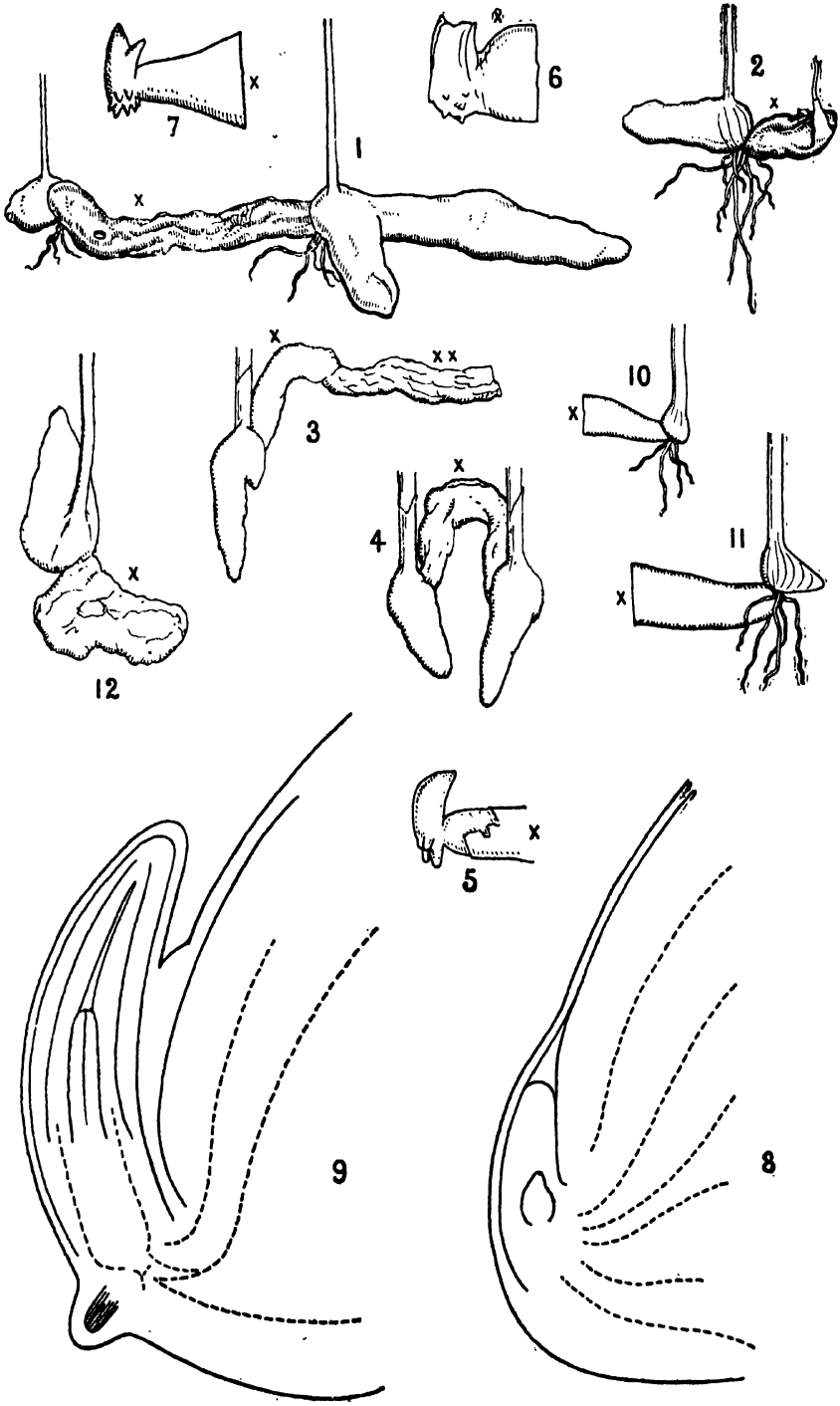
Fig. 8. Section through the apex of a corm, showing the developing bud scale ; x 20.

Fig. 9. Ditto ; an older stage ; x 20.

Fig. 10. Apex of old corm, and base of stem of the young plant ; nat. size.

Fig. 11. Apex of old corm, and base of stem of the young plant, showing development of the long arm of the new corm ; nat. size.

Fig. 12. New corm directed upwards, because the old corm was planted too deep ; nat. size.



Block by Survey Dept. Ceylon

Notes on Ceylon Thelephoraceae, etc.

BY

T. Petch, B.A., B.Sc.

STEREUM

Among the fungi sent from Ceylon by Gardner, Berkeley recorded **Stereum nitidulum** Berk., a species which he had previously described from Brazil. The specimens were accompanied by a painting which is now in the Kew Library.

In the Fungi of Ceylon, No. 586, Berkeley and Broome again recorded this species, without any collection number, and added the note, " a large form possibly distinct ; more fasciculate in its mode of growth, more divided, and marked with little raised lines. The normal form was collected in Ceylon by Gardner. " These specimens were Thwaites 62. The painting of Thwaites 62, however, was labelled *Stereum elegans*, and on it there is a reference to Jour. Linn. Soc., XV, p. 388, No. 300, *i.e.* to the record of *Stereum elegans* in Berkeley and Cooke's Fungi of Brazil, though there is no mention there of the Ceylon fungus. Berkeley labelled the specimens, " *Stereum nitidulum* B. *forma major. Stereum elegans* var. " One of the specimens from Thwaites 62, *ex* Herb. Currey, is included under *Stereum elegans* in Herb. Kew. The painting shows two groups of pilei, which differ in colour.

Lloyd, Synopsis of the Stipitate Stereums (1913), states that the specimens from Ceylon referred by Berkeley to *Stereum nitidulum* should be assigned to *Stereum elegans*, but it is not clear to which collection his statement refers. The Kew sheet, Thwaites 62, bears a note by Bresadola, " a Stereo nitidulo typo certe specifice diversum, nec var. imo nec omnia specimina identica sed duas sistunt formas scilicet a—e unam, f—h aliam. "

A point which adds considerably to the difficulty of determining these cartilaginous species of *Stereum* does not appear to have been generally recognised. It is that the hymenium develops late, and the fungus may attain its full stature before the hymenium is formed. Consequently, herbarium specimens are very liable to be deficient as regards cystidia, etc. The development of the hymenium in *Stereum elegans* and allied species would appear to require investigation.

The specimens, Thwaites 62, marked f—h by Bresadola in Herb. Kew, are the common form attributed to **Stereum elegans** in Ceylon. This grows in rosettes, up to 15 cm. diameter, often concentrically, the individual pilei being infundibuliform, flabelliform, or spathulate, separately stalked but concrescent above. Its colour is unattractive, being pallid, or pale brownish white, with obscure, deeper brown, concentric zones. When dry it is usually almost black, not zoned, glabrous, and finely radially ridged, but young specimens may dry deep red brown. The stalk when fresh is pallid, or pale yellow, or ochraceous, and minutely tomentose ; when dry it is densely covered with short, erect, rufous tomentum, or has a paler brown, or almost white, felted covering, according to the age of the specimen when gathered. This tomentum extends up to the base of the pileus. The spores are white, subglobose, 3-4 μ diameter. The hymenium contains scanty cystidia, rough, narrow flask-shaped or fusoid, 30 μ high, 6 μ diameter, which do not project.

The above form grows on the ground, but that statement is misleading without further explanation. It usually grows on the ground, in the neighbourhood of half-buried wood. In one occurrence, it appeared in nursery beds which had been bordered by planks, half-buried on edge, to retain the beds in shape. The rosettes of the fungus sprang up on the soil, but close to the wood, the mycelium evidently originating from the latter.

The second form, marked by Bresadola *a-e*, has much the same habit, but the pilei are usually in smaller clusters. Individually they are larger, more flabelliform and lobed, and sometimes infundibuliform. The colour when fresh is brighter, pale yellow to ochraceous, with distinct, yellow-brown to purple-brown, concentric zones. In drying it becomes deep red brown, but usually retains its zonation. The surface is rather more coarsely ridged than in the previous form when dry, and it is generally, but apparently not always, minutely scabrid with short, brown, scattered hairs. The stalk, in the dry specimens, is densely covered with short, rufous tomentum, and when growing on wood it has a distinct, matted, strigose, rufous pad at the base. Cystidia have not been found in this form.

The habitat of this second form varies. Thwaites' specimens appear to have grown on the ground. A recent collection from Anuradhapura, with identical pilei, certainly grew on wood, and they have a well-developed pad at the base of the stem. Another collection was brought to me with the information that the specimens grew on a jak log : the stalks are exactly like those of Thwaites' specimens, and they evidently grew at the junction of the log and the soil.

It would seem probable that this second form is **Stereum surinamense** Lèv. though the latter is said to be smooth and to lack the basal mycelial pad.

Consequently, *Stereum nitidulum* Berk. must be deleted from the Ceylon list as far as regards Thwaites 62. The specimens sent by Gardner, and referred to *Stereum nitidulum* by Berkeley in Decades of Fungi, after No. 183, are, however, not the same species as Thwaites 62. I have specimens from the low-country which exactly match Gardner's figures and these are not *Stereum elegans*. They grew on dead wood, and when fresh were ivory white, slightly translucent. After drying they are bay, with concentric darker zones. Gardner's figures show an intermediate stage of drying. The specimens are about 1 cm., high, 8 mm. diameter, stalked, infundibuliform or obliquely infundibuliform, glabrous, and cartilaginous. The stalk is stout, and arises from a circular, fleshy, basal disc, up to 6 mm. diameter, which appeared glabrous when fresh, but is minutely pruinose when dry. Erect processes arise from the base of the funnel, as in *Stereum hydrophorum*, but in these examples they do not extend to the level of the rim.

Another collection, from Peradeniya, consists of similar specimens, but different in colour, red brown with darker concentric zones. These also grew on wood. They are regularly infundibuliform, up to 1.5 cm. high, 2 cm. diameter, with a stout base, or short stalk, either terete, 5 mm. diameter, or laterally compressed, up to 8 mm. broad and 3 mm. thick. When fresh the stalk was yellow ; it arises from a broad basal disc, up to 1 cm. diameter, glabrous when fresh, minutely pruinose when dry. The specimens were cartilaginous when fresh, and adjacent examples have coalesced laterally ; dry, they are horny, but the rather thick tissue at the base of the funnel is white and corky internally. In each specimen, the funnel is filled with erect forked processes, which form a rosette arising above the rim. In one example, the outer half the pileus is decurved, and this has a rosette of processes in the funnel, and tufts of similar processes in a circle on the decurved part.

These specimens are evidently an abnormality similar to that which occurs in *Stereum hydrophorum* ; but it is not the latter species as the pileus is glabrous. The specimens represented by Gardner's figures are apparently normal. All the available examples appear to be immature, and no larger specimens have been collected to which these might be referred. They differ from *Stereum Mellisii* in texture, and in the basal disc, which is not fibrillose ; while the latter feature and the stout stalk distinguish them from *Stereum surinamense*. When fresh, they bear a marked resemblance to *Polystictus xanthopus*. I would place them under **Stereum curtum** Fr., which was described as having a circular, dilated

base, adnate to the wood, as in these examples. Lloyd (*op. cit.*) states that *Stereum curtum* appears to consist of small depauperate specimens of *Stereum surinamense*.

Thwaites 682 was assigned to *Stereum elegans* by Berkeley and Broome in Fungi of Ceylon, No. 587. Lloyd (*op. cit.*) refers these to *Stereum surinamense*. But the corresponding specimens in Herb. Peradeniya have a thick, brown, circular, strigose pad, up to 1 cm. diameter, at the base of the stem, and rough, hyaline, conical or cylindric cystidia, 24-36 μ high, 8 μ diameter, which project about 16 μ above the hymenium. Hence these would appear to be **Stereum Mellisii** Berk., not *Stereum surinamense*.

Stereum floriforme Bres. has been collected at Peradeniya on two occasions. In one collection the pilei are for the most part regularly reniform, as in *Stereum affine* Lév.; these specimens grew on wood. In the other collection they are more variable; some of the examples of the latter grew on the soil at the base of a stump and others on the stump to a height of eight inches from the ground.

Stereum malabarense Cke. (det. Lloyd) has been gathered at Kalupahani (No. 4426, April 1912).

Stereum partitum B. & Br., Fungi of Ceylon, No. 588, is referred by Lloyd to *Stereum glabrum* Lév.

Stereum tuba B. & Br., *fide* Lloyd, is a *Cyphella*, *Cyphella tuba* (B. & Br.) Lloyd.

Stereum pusillum Berk. was described by Berkeley from a specimen in Herb. British Museum which had been collected in Ceylon by König, and consequently in the Trincomalie—Batticaloa district. Lloyd states (*op. cit.*) that as to habit and colour it is the same as *Stereum nitidulum* and *Stereum Ravenelii*, and very close to the latter.

Stereum lobatum Fr. The hymenium of this species is usually red or brownish red when wet. The spores are white, narrow-oval, 4-6 x 2.5 μ. Burt (Ann. Missouri Bot. Gard., VII. p. 155) refers *Stereum ostrea* (Bl. & Nees) to *Stereum fasciatum* Schw., and holds that the common tropical *Stereum lobatum* is distinct. Our Ceylon species is certainly *Stereum ostrea*, as figured in the original publication. In the Ceylon species, the umbo is the part of the fungus first formed. If it is growing on a subvertical surface, the upper edge develops into the flabelliform pileus while the lower edge may remain small or may grow over the substratum as a resupinate lower half. If the fungus grows on the lower surface of a branch, the pileus may be distinctly centrally stalked and broadly concave or infundibuliform. Adjacent pilei fuse, and form long lines of concrescent cups, or a long narrow pileus divided at the base. Burt states, with regard to *Stereum fasciatum*, that "the fructifications are

at first effuso-reflexed with the resupinate portion up to one centimetre broad, the reflexed portion 1½ cm. from base to margin, and with a lateral extent along the substratum of 2-8 cms.; umbos soon form at points 1-2 cm. apart along the line of intersection of the plane of the reflexed portion with the substratum." The development of the Ceylon species is the reverse of this ; the pilei are not attached except at the umbo.

Stereum perlatum Berk. Specimens, No. 3637, Dec. 1912, exactly match McGregor, Bureau of Science, No. 10553, det. Bresadola as this species. The upper surface is tomentose at first, with short grey tomentum, becoming glabrous when old. It has the habit of *Stereum lobatum*, but is thinner, concentrically and radially ridged, deep purple brown, almost black behind.

Stereum percome B. & Br. The old herbarium specimens of this species (Thwaites 983) have the hymenial surface bright yellow-brown, and the zoned, strongly strigose, upper surface pale brownish grey. The thickness of the free edge is about 0.2 mm., excluding the strigose layer, and the context appears dark brown in section, macroscopically. By transmitted light, however, only the hymenial layer and the tissue immediately beneath it is dark brown, the remainder being pale yellow. The "hymenium" consists of rough, yellow hairs, 5 μ diameter, slightly inflated at the tip, arranged in a loose palisade layer. Basidia have not been seen.

In recent specimens the colour is variable. In one collection, the hymenium is yellow-brown, with a narrow lavender edge : in another, it is rufous brown, bordered by a narrow purple-brown zone and a lavender edge.

Bresadola (Ann. Myc., XIV, p. 232) refers this species to *Lloydella papyracea* (Jungh.) Bres. The latter, *Stereum papyraceum* Jungh., is described in Saccardo as "livido-expallens ; pileo margine libero undulato-zonato, glabriusculo, hymenio sub lente velutino." The colour of the Ceylon specimens is different, they are strongly radially strigose, and there are no projecting setae on the hymenium. Apparently all the available Ceylon specimens are immature. The hymenial surface consists of rather distant hairs, all attaining the same level, and it is doubtful whether these can be regarded as cystidia or gloeocystidia.

Stereum papyrinum Mont. This was recorded for Ceylon by Berkeley and Broome from Thwaites 220, 740, 257, 536 and 544. In Grevillea, VIII, p. 20 (1879), Cooke transferred *Stereum papyrinum* Mont. to *Peniophora*, citing as localities, "Australia, Ceylon, Brazil, etc." Cooke's figure of the cystidia shows them rough. Massee accepted Cooke's reference, and cited a specimen from Montagne in Herb. Berk.

In Ann. Myc., IX, p. 271 (1911), Bresadola transferred *Stereum papyrinum* Mont. to *Lloydella*, as *Lloydella membranacea* (Fr.) Bres.,

stating that the cystidia were smooth. The latter statement is directly opposed to Cooke's and Massee's, to Cooke's figure, and to the Ceylon specimens, and if correct the Ceylon specimens are not *Stereum papyrinum* Mont. Consequently, Cooke's name will be retained for them.

Thwaites 740 is apparently *Peniophora papyrina* Cke. as described by Massee. Thwaites 257 was given by Berkeley and Broome as *Trametes lobata*, *Stereum papyrinum*, and *Psilonia gilva*; it is *Psilonia gilva* in Herb. Peradeniya, and *Trametes cervinogilvus* in Herb. British Museum. Thwaites 536 in Herb. Peradeniya is a *Peniophora*, on charred wood, and is identical with *Corticium lilacinum* B. & Br. which was described from Thwaites 997, also on charred wood. Thwaites 544 was stated by Berkeley and Broome (*sub* Fungi of Ceylon, No. 585) to be an imperfect state of *Thelephora accumbens* or some allied species, and it is included in the cover of *Thelephora accumbens* in Herb. Kew; it is not *Peniophora papyrina*. Thwaites 220 is *Corticium* (*Duportella*) *tristiculum*.

Cooke's figure and measurement (35 x 12 μ) of the cystidia may have been taken from Thwaites 740, though the breadth is too large. Massee's measurement (80 x 12 μ) is nearer that of Thwaites 536.

Stereum notatum B. & Br. Berkeley and Broome described this species as "effusum, margine tomentoso pallido libero; hymenio hic illic concentrice notato pallido": and added the note, "spreading for several inches. At first looking like a little *Cyphella*; but the individuals soon become confluent; hymenium marked with concentric rings; edge thin papyraceous." Massee stated that, judging from the stains on the dried specimens, it gave out a red juice when bruised.

The specimen of *Stereum notatum* in Herb. Peradeniya includes a resupinate piece measuring 10 cm. x 4.5 cm., marked here and there with concentric ridges. It is evidently composed of several individual pilei united laterally, each series of concentric ridges denoting a separate pileus. Apparently it grew on the lower surface of a log, so that it is almost entirely resupinate, becoming free towards the margin. Recent collections are circular, only centrally attached, sometimes dorsally attached towards one edge, flabelliform and lobed. When dry it is rigid and somewhat horny, the total thickness being about 0.35 mm. The dorsal surface is strongly radially strigose with coarse, white or brownish white fascicles, and marked with narrow concentric zones. The hymenium is greyish brown to purple grey, turning deep red when bruised. The hyphae on the dorsal surface are thick-walled, regular, flexuose, hyaline or yellowish, 2-3 μ diameter. In section, the dorsal surface is yellow and composed of agglutinated yellow-brown hyphae, similar to the free hyphae; the context is pale yellow to hyaline; the hymenial layer is translucent, and contains numerous, dark brown, latex tubes, which run

sub-horizontally in the context, and curve upwards into the hymenium, where they are about 7 μ diameter. In some specimens, and in the type, the contents of these tubes are dark brown, but in young specimens they may be yellow-brown or hyaline. In general appearance, this species bears a considerable resemblance to *Stereum rimosum*, but it is thinner than that species and differs in colour and in the character of the dorsal tomentum.

Stereum rimosum Berk. Specimens matching those from Ceylon assigned to this species by Berkeley and Broome have been collected recently at Hakgala and Peradeniya. When fresh the hymenium is orange yellow, becoming crimson when bruised ; it is usually concentrically ridged and sometimes tuberculate, and cracks on drying. The pilei are generally circular, umbonato-sessile, centrally attached, frequently adherent to the substratum elsewhere by the tomentum of the dorsal surface. The herbarium specimens are up to 1·5 mm. thick in the centre, the recent specimens only about 1 mm. thick. The dorsal surface is spongy tomentose, sometimes radially strigose towards the margin, and zoned with brown or yellow-brown beneath the tomentum. The fungus appears waxy when fresh, but in drying becomes rigid or coriaceous, and if allowed to dry without pressure, generally cup-shaped. The hymenium includes gloeocystidia which contain irregular yellow granules.

Stereum Lepra B. & Br. Massee transferred this to *Corticium* (Mon. Theleph., p. 130). It has been redescribed as *Aleurodiscus Lepra* (B. & Br.) v. H. and Litsch., in Sitzungsber. d. k. Akad. d. Wissensch. Wien, Mathem.-naturw. Klasse, Bd. CXVII, p. 1098 (Oct. 1908).

Stereum sparsum Berk. This has been recorded in Saccardo for Ceylon and Australia. The Ceylon record is an error, due to confusion with *Corticium sparsum* B. & Br., which is a *Peniophora* and was transferred to *Peniophora* by Cooke in Grevillea, VIII, p. 21.

Berkeley and Broome described, in the Fungi of Ceylon, three species of *Stereum*, *viz.*, *Stereum albocinctum*, *S. endoleucum*, and *S. duriusculum*, which have since been the subject of considerable difference of opinion. Massee, Mon. Thelephoreae, referred all these to one species, citing " auriusculum " in error, and included with them, *Stereum annosum* B. & Br., another Ceylon species, stating that the spores were 4 x 3 μ. Bresadola, in Ann. Myc., XIV, p. 232, stated that *Stereum duriusculum* was the same as *Stereum albocinctum* ; in his notes on the sheets in the Kew Herbarium he wrote, " *Stereum duriusculum* est la même espèce " on the sheet of *Stereum albocinctum* ; " *Stereum duriusculum* B. & Br., *Stereum induratum* Berk. type, et *Corticium portentosum* B. & C. sont pour moi tres

formes d'une même espèce," on the sheet of *Stereum duriusculum* ; and "mihi valde dubia species, certe non *Stereum*," on the sheet of *Stereum endoleucum*.

In Bull. Soc. Myc. France, XXXVI, p. 75, Bourdot and Maire recorded the result of their examination of the type of *Stereum duriusculum*. They stated that the type was sterile. It formed a plate, scarcely 1 mm. thick, rigid and fragile: the context was wood-colour to pale fawn, the surface pale clay-coloured. The ultimate branches of the hyphae were elongated, almost flagelliform and rather hyaline, so that the fungus appeared to be near *Corticium portentosum* (American specimens). Bourdot and Maire stated that *Stereum duriusculum* and *S. albocinctum* belong to a group of species characterised by much branched, dendroid hyphae, which ought to be included in the genus *Asterostromella* ; they would not modify the conception of that genus except to extend it to substratified species, with a coloured context, and with spores frequently spherical and rough.

Stereum albocinctum B. & Br. The type specimens (Thwaites 661) are now pale brownish white. They may have been white or cream-coloured when fresh. Berkeley and Broome described them as isabelline and also as a delicate fawn colour. They are irregularly oval or lobed, a few centimetres long and broad, undulating, entirely adnate, with a rounded or sub-vertical margin which is either of the same colour as the remainder of the surface, or chalky white, or, on the thicker pieces, white above and pale brown below. The thickness varies from 1·5 to 3 mm. Internally the fungus is cinnamon brown, somewhat obscurely stratose, rather friable and soft, easily cut but tending to break up. The internal zones, as seen in section, are narrow, about 120 μ broad, but they separate horizontally in thicker layers, about 0·5 mm. thick. The hyphae in each zone are irregularly interwoven below, becoming more or less parallel and vertical above, the direction of the hyphae in general being vertical. They are brownish yellow, and not fused, or only slightly fused, into a continuous mass. The larger hyphae are 2—3 μ diameter, thick-walled, rigid, and branch at a wide, rounded angle, so that they have the appearance of an old oak tree. These give rise to finer hyphae, 1—1·5 μ diameter, which fork and branch repeatedly, giving off short spine-like branches. These finer hyphae become solid. Entangled among these hyphae are oval,yellow-brown, spinulose spores, 6 x 4 μ. The surface is minutely tomentose with fine, branching, hyaline hyphae, 1·5 μ diameter. and a few, projecting, yellow-brown hyphae, 2 μ diameter. Basidia have not been seen.

Stereum endoleucum B. & Br. was Thwaites 996, not 966 as given in the Fungi of Ceylon. The specimens are apparently on a palm stem.

They are resupinate, greyish white, sometimes with a paler margin, the margin being tomentose or substrigose, rounded, sometimes free and slightly recurved. The total thickness is about 1·5 mm., and the context is rather soft, crumbling when cut, not stratose, but feebly vertically ridged on fracture. The specimens are fragile and transversely cracked. The internal colour is now the same as that of the upper surface: Berkeley and Broome stated that the hymenium was "ochroleucum," and the context "niveum." The hyphae are hyaline, stout, irregular, thick-walled, up to 6 μ diameter, with a lumen reduced to 1.5 μ diameter, or sometimes solid. On staining with cotton blue, only the contents of the hyphae stain. Most of the hyphae, however, are empty, and consequently the blue stained lines, only 1—1·5 μ broad and widely separated from one another, appear at first sight to be another fungus permeating the *Stereum*. The hyphae are loosely coherent and run more or less vertically. At the surface they form a more compact, narrow, palisade layer, with a few projecting hyphae. Basidia have not been observed.

For **Stereum duriusculum,** Berkeley and Broome cited Thwaites 329, 560. The specimens are 329, 569. The fungus when fresh is cream-coloured. Berkeley and Broome stated that it was ochraceous, and the specimens are now somewhat brownish ochraceous. They are effused, up to 1·5 mm. thick, internally brownish white, or very pale brown, and markedly stratose. The context is firmer than in *Stereum albocinctum*, and it does not cut so easily. In section by transmitted light, the context is zoned with alternate hyaline and pale yellow zones. The hyphae are 2—3 μ diameter, irregular, some solid, others thick-walled, giving off finer branches, long and flexuose, down to 0·75 μ diameter. The tissue is more compact than in *Stereum albocinctum*, and the hyphae differ in colour and mode of branching. In the yellow zones the hyphae are more closely interwoven than in the hyaline zones. It appears that the hyaline part is the lower part of each growth zone, while the yellow part marks its upper limit. The surface is tomentose with projecting hyphae, 1·5 μ diameter, which give rise to very fine hyphae, studded with granules. No basidia have been found. Crystals of calcium oxalate occur in the lower layers of the context.

There can be no doubt that, whether they are Stereums or not, *Stereum albocinctum*, *S. endoleucum*, and *S. duriusculum* are all distinct from one another and distinct from *S. annosum*. What they really are is doubtful, but it would seem probable that they are *Ceriomyces* forms.

Massee, in Mon. Thelephoreae, recorded *Stereum rugosum* Fr. for Ceylon. The specimen in Herb. Kew is Thwaites 993, and it is clearly *Stereum albocinctum* B. & Br. Berkeley and Broome cited Thwaites 993, *inter alia*, for their *Stereum ruberrimum*.

In Fungi of Ceylon, No. 623, Berkeley and Broome recorded **Corticium laeve** Fr., citing Thwaites 329, 331, and 607. These three are different species. Thwaites' sheet marked 329, 369 in Herb. Peradeniya contains specimens of both numbers ; one of these is *Stereum duriusculum*, as in the type of the latter, while the other is a younger growth of the same. The latter forms an effused patch over 10 cm. long and 4.5 cm. wide, and shows the internal yellow zones only in the thicker parts. Thwaites 607 was described by Berkeley and Broome in Fungi of Ceylon, No. 649, as *Corticium ambiens* B. & Br.

Stereum annosum B. & Br. is quite different in appearance and structure from the three species with which Massee included it. The internal colour resembles that of *Fomes applanatus*. The colour of the hyphae is similar to that of the hyphae of *Stereum albocinctum*, but the hyphae are stout, 4 μ diameter, and for the most part regular and normal in character.

Another species, similar to *Stereum duriusculum*, but clearly distinct, has been collected on several occasions at Hakgala. In general, it forms oval or irregular, thick plates, a few centimetres broad, resupinate, becoming undulating and partly free, with a rounded margin. One specimen, however, gathered with the common form, on a branch 1·5 cm. diameter, extends in a continuous layer for 12 cms. along the branch, thinning out laterally without a definite margin. The stroma is white at first, becoming ochraceous when old, and blackish at the base. It is up to 4 mm. thick, very hard, and closely laminated internally, consisting of pallid or pale yellow subtranslucent plates, separated by white chalky zones which vary in width from 20 to 250 μ. The white zones are not regular, but broaden out here and there into pockets. A specimen 4 mm. thick shows twenty or more superposed plates. In section, the plates are hyaline, and the hyphae of which they are composed are fused into a sclerotioid mass. The white lines or pockets between the plates consist of aggregations of irregular granules of calcium oxalate, permeated by a few hyphae. The superficial layer, external to the uppermost sclerotioid layer, is about 20 μ thick, and consists of clavate or narrowly conical hyphae, up to 20 μ high. Some spherical spinulose spores are present on the outer layer but they appear to be intrusive. This species was apparently not collected by Thwaites.

Stereum insulare B. & Br. was described by Berkeley and Broome as "pallide umbrinum." Massee stated that it was dirty ochraceous. It forms circular or elongated patches, 1 cm. diameter, or 2 x 1 cm., brownish grey, pulverulent, cracking on drying, with a definite, but thin, margin, which is at first tomentose but becomes black and glabrous. The total thickness is about 0·15 mm. Internally it is dark brown, the

hyphae being yellow-brown by transmitted light. The hymenium contains, or in these specimens consists of, closely-packed dendrophyses, 3-4 μ diameter, which branch below, the branches expanding at the apex, forking once or twice, and terminating in short, stout processes which bear numerous spines up to 3 μ long. The apices of the dendrophyses are usually hyaline, and in form they resemble a stout *Clavaria*. Basidia have not been seen. The available specimens appear to be practically a palisade layer of paraphyses. If the fungus is really a Basidiomycete, as it appears to be, it should be referred to *Aleurodiscus*.

Thelephora dentosa B. & C. In Fungi of Ceylon, No. 573, Berkeley and Broome recorded *Thelephora dentosa* B. & C., from Thwaites 343, stating that it grew on rotten wood, and added the note " Exactly the Cuban plant." In Berkeley and Curtis, Cuban Fungi, No. 379, Berkeley cited two of Wright's collection numbers for *Thelephora dentosa*, one, No. 507, from his first collection, and the other, No. 238, from his second ; and added that the name applied better to 507, which had been distributed, No. 238 being more like *T. palmata*. *Thelephora dentosa* was said to spread over the surface of rotten wood, leaves, and other vegetable matter, giving off distinct branches which were sometimes dilated in a flabelliform manner above : sometimes the hymenium was formed where the fungus ran over the leaves. The colour of the fungus was ochraceous, rufous brown below, with the hymenium rufous brown.

Burt (Annals Missouri Bot. Gard., I, p. 224) states that the two collections are two different species. He takes No. 507 as *Thelephora dentosa*, and names No. 238, *Thelephora perplexa*. He does not refer to the Ceylon collection.

From Berkeley's description, and Burt's amended account, of the Cuban fungus, it is clear that the Ceylon *Thelephora dentosa* is a different species. The Ceylon specimen is Herb. Kew is marked by Lloyd, "Cited in error in Saccardo as type, not same species."

The Ceylon fungus does not grow on dead wood, etc., and it is not encrusting. It grows on the ground, stalked and erect, more or less in clusters after the fashion of *Stereum elegans*, but not definitely rosetted. Small specimens, up to about 7 mm. high, are spathulate or flabelliform, about 4 mm. diameter above, entire, attenuated below into a short stalk about 1 mm. diameter. Larger specimens are up to 2·5 cm. high, 2 cm. broad above, generally deeply divided into cuneate lobes, the longer divisions reaching almost to the base. Adjacent pilei are concrescent laterally. The fungus is fleshy, not horny, and becomes rigid on drying. When fresh the colour is pallid, or brownish grey, or purple grey, obscurely zoned; when dry, it is brownish grey and pruinose on the dorsal surface, dark purple grey below. The dorsal surface is sometimes radially ridged.

The pileus is stout, about 0·5 mm. thick, fibrous internally and pale yellow in mounted sections. Cystidia are absent, and the fungus does not turn red when bruised. Spores have not been observed.

This species is a *Stereum*. It differs from *Stereum partitum* in its texture and its more divided pilei. In texture it resembles *Stereum Thwaitesii* (*Cladoderris Thwaitesii* B. & Br.), but it differs from that species in not changing colour when bruised. It may be known as *Stereum divisum*.

Stereum divisum Petch, n. sp. Pilei stalked, spathulate or flabelliform, plane, up to 2·5 cm. high, 2 cm. broad above, repeatedly divided into cuneate lobes, the longer divisions extending almost to the base, thick, fleshy when fresh, rigid when dry; pallid, brownish grey or purple grey when fresh, obscurely zoned; when dry, brownish grey and pruinose above, dark purple grey below; dorsal surface sometimes radially ridged; context fibrillose; cystidia absent. On the ground, often in clusters, adjacent pilei laterally concrescent. No. 6099, Dewalakande, August 1919.

Stereum tenerum Petch, n. sp. Dimidiate; pilei orbicular, upper surface white, hymenium pale violet, becoming ochraceous when old, up to 2 cm. long, 1 cm. broad, arising from a continuous resupinate patch; thin, total thickness about 0·6 mm., tender, upper surface silky tomentose, hymenium concentrically undulating. Dorsal layer spongy, about 0·4 mm. thick, of decumbent, hyaline to yellow-brown, thick-walled hyphae, 2 μ diameter, united into coarse, yellow, flexuose strands, 16 μ diameter, which give off numerous free, hyaline hyphae; dorsal hyphae fused below into a continuous, yellow-brown, subtranslucent layer, 0·1 mm. thick; context hyaline, loose, 0·1 mm. thick; hymenial layer 30 μ thick, without cystidia or gloeocystidia.

Hakgala, April 1924: No. 4063. The colours of the fresh specimens are those of *Polystictus elongatus*. When dry, the hymenium becomes greyish brown, and preserved herbarium specimens are red-brown.

Stereum ruberrimum B. & Br. For this species Berkeley and Broome cited Thwaites 323, 462, and 993. No. 993 was included in Herb. Berkeley as *Stereum rugosum* Fr., and it is actually *Stereum albocinctum* B. & Br. The description of *Stereum ruberrimum* is "Pulvinatum; hymenio pulchre rubro in basi nigra insidente; margine angustissimo albo. On lichens and their apothecia." Massee included it in *Stereum* in his Monograph of the Thelephoreae, adding that the spores were ellipsoid, 6 x 4 μ.

In Thwaites 462, the red colour is confined to the lichen fructification. The disc is rather dark purple red, with occasionally a slight reddish coloration on the surrounding thallus. In section, the colour is found to extend to the base of the apothecium, varying from purple red to

red brown. It is due chiefly to minute, red spherical globules, up to 4 μ diameter, which encrust the paraphyses. The mature ascospores are slightly tinged brown, but the immature spores may be red brown, in the herbarium specimens. The latter effect is probably due to preservation with alcoholic mercuric chloride, as the colouring matter is soluble to some extent in alcohol. This specimen does not agree with Berkeley and Broome's description. There is no pulvinate stroma, the margin is not white, and there is no black base except the wall of the apothecium. The whole of the tissue is apparently that of the lichen, and there is no *Stereum* present. The specimen is a lichen with the disc of the apothecium purple red.

The other specimen, Thwaites 323, is on a lichen, which has not developed fructifications. The supposed *Stereum* is vermilion. In some places, it consists of a thin, diffuse, discontinuous, powdery patch, which sometimes borders a crack in the lichen thallus. Elsewhere are definite, more or less circular, irregularly tuberculate, powdery, vermilion patches, up to 5 mm. diameter, sometimes with a narrow, black margin. They are not, in the specimens examined, seated on a black stroma, the latter being merely marginal. The irregularity of the red stroma is due to irregularities in the substratum. In section the stroma is 80—100 μ thick, purple red by transmitted light. Underlying the red part there may be a hyaline tissue up to 110 μ thick, but this apparently occurs only in hollows of the substratum. The purple red layer consists of loosely intertwined, hyaline hyphae, about 1 μ diameter, densely encrusted with irregularly angular, purple red granules, which sometimes form masses up to 12 x 8 μ. These granules are not affected by hydrochloric acid. The hyaline basal tissue consists of similar hyphae, loosely interwoven, among which are embedded large numbers of crystals of calcium oxalate. The colouring matter is slightly soluble in alcohol, but is not altered by lactic acid or hydrochloric acid. There is no indication that this specimen is a *Stereum*, and it would seem probable that it is a state, perhaps abnormal, of the lichen.

Stereum acerinum Fr. As stated in Ann. Perad., VI, p. 157, the Ceylon specimens attributed to this species in Fungi of Ceylon, No. 603, are not a fungus.

Stereum sulphureum Fr. The specimens recorded under this name in Fungi of Ceylon, No. 602, are identical with *Corticium flavo-rubens* B. & Br. They are also the basis of Massee's record of *Stereum strumosum* Fr. for Ceylon (see Ann. Perad., VI. p. 156).

HYMENOCHAETE

Hymenochaete subpurpurascens (B. & Br.) Massee. This was described by Berkeley and Broome as *Stereum subpurpurascens*, in Fungi

of Ceylon, No. 598. It was transferred to *Hymenochaete* by Massee, Mon. Theleph., p. 101. The pileus is dimidiate, or circular and centrally attached, closely concentrically sulcate above, minutely radially strigose, becoming almost glabrous, rigid, up to 1·5 mm. thick, dark purple-brown. The lower surface is purple-brown, smooth, without evident setae. The context is fibrillose, sudan brown to amber brown, with a thin, black, solid, dorsal layer underlying the tomentum ; the hymenium is purple-brown, darker than the context. In section the hymenium is stratose ; it is composed of crowded fusoid setae, 4-8 μ diameter, slightly encrusted, with a subacute apex, not, or barely, projecting. In recent specimens, the hymenium is olive-brown. with a bright red-brown margin ; these specimens are thinner than the type, the hymenium is not stratose, and the setae project up to 24 μ. Specimens, No. 523, E. B. Copeland, Flora of the Philippines, stated to be determined by Bresadola as *Hymenochaete cacao* Berk., appear to agree with the thinner form of *Hymenochaete subpurpurascens*.

Hymenochaete rigidula B. & C. This was originally described by Berkeley from Cuba. It has been re-described by Burt, who states that the upper surface is snuff-brown, and the hymenium benzo-brown, with an ochraceous tawny margin. The Ceylon specimens named by Berkeley and Broome are entirely resupinate ; the dorsal surface is near antique brown but brighter, rather strongly matted tomentose, with the tomentum inclined to be massed in small cushions ; the hymenium is Prout's brown, with a yellow ochre margin ; the setae are somewhat crowded, conical, acute, 30-50 μ long, 6-8 μ diameter, projecting 16-30 μ; the fungus is about 1 mm. thick, and a thin, black, dense, dorsal layer underlies the tomentum.

Specimens, which appear to be identical with Thwaites's collection, have been gathered recently, in all cases on very decayed stumps. They consist of masses of imbricated pilei, the resupinate part being small and irregular, probably because of the nature of the substratum. The tomentum of the dorsal surface is well-developed. The free margins are up to 2 cm. broad, closely concentrically sulcate, with minutely tomentose, Argus brown zones, alternating with glabrous, black lines. The hymenium is slightly darker than in the Thwaites specimen, and the margin is antique brown.

It would seem probable that the Ceylon species is not the same as that from Cuba.

Hymenochaete tenuissima (Berk.). This was described by Berkeley from Ceylon specimens as *Stereum tenuissimum* in Decades of Fungi, No. 184 (1847). In Jour. Linn. Soc., X (1868), p. 333, Berkeley and Curtis recorded *Hymenochaete tenuissima* Berk. from Cuba, with a re-

ference to the Ceylon fungus ; the Cuban specimen, however, has since been found to be a different species. In Fungi of Ceylon, No. 607 (1873), Berkeley and Broome recorded the Ceylon fungus again, as *Hymenochaete tenuissima* Berk. (*Stereum tenuissimum*, Hook. London Jour., 1847, p. 510), from Thwaites 10 and 534. Bresadola, in Ann. Myc., XIV, p. 233, states that *Hymenochaete tenuissima* is identical with *Hymenochaete rheicolor* Mont., and he has attached a note to that effect to the Ceylon specimen in Herb. Kew which was collected by Thwaites in 1850.

In Herb. Kew, there are, in the cover of *Hymenochaete tenuissima*, the type specimen collected by Gardner on the Horton Plains in February 1846 ; specimens collected by Thwaites in 1850, 1851, and 1854 ; Thwaites 10 and 534 ; and a Thwaites specimen without a number.

In Fungi of Ceylon, No. 609, Berkeley and Broome recorded **Hymenochaete crocata** Lév., collected by Thwaites in 1850. This Ceylon specimen in Herb. Kew is the thicker form of *Hymenochaete tenuissima*.

Hymenochaete leonina B. & C. was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 614, from Thwaites 335. In the cover of *Hymenochaete leonina* in Herb. Kew, there is a piece of Thwaites 335 which is marked *tenuissima* by Berkeley, another piece which is also *tenuissima*, and a third piece which is *Hymenochaete barbata* Massee. Massee removed two pieces of this Thwaites number to the cover of his new species, but apparently overlooked this third piece.

Hymenochaete spadicea was described from Thwaites 534 in part. The specimens were apparently imperfectly separated, and the type of *Hymenochaete spadicea* contains both that species and *Hymenochaete tenuissima*.

Hymenochaete rheicolor Mont. (*Hymenochaete tenuissima* Berk.) is common in up-country jungles in Ceylon. It usually grows on small dead branches, producing orbicular pilei, centrally attached, which increase until they fuse laterally and form a continuous stroma, often extending for several feet along the branch, with a free lobed margin, up to three or four centimetres wide, on either side. The resupinate part is usually separable from the substratum. Sometimes it spreads along the branch in a continuous sheet, and produces flabelliform pilei at the margin. When growing on larger fallen branches, the resupinate part may be 10 cm. or more broad, and pilei may arise by secondary growth on these patches. On vertical surfaces, imbricated flabelliform pilei are produced, usually in small groups, only slightly decurrent behind. It may spread from the branches to dead leaves, etc., on the ground.

The colour of the pileus is at first gilvous, or raw sienna, becoming antique brown, and finally Argus brown. The hymenium is raw sienna or yellow ochre at first, becoming cinnamon brown and finally Prout's

brown. Large resupinate patches may show a secondary growth, yellow ochre in colour, here and there over the old hymenium. The setae are clearly visible with a hand lens.

The dorsal surface is concentrically sulcate usually radially strigose, sometimes matted strigose without definite radial fascicles. In general the pileus is thin and papery, the total thickness, without the strigose layer, being 0·1—0·15 mm.; the context is composed of hyphae more or less parallel to the hymenium and merges into the strigose layer without any definite zone of separation. In some gatherings, however, the pileus is more rigid, and inclined to crack when bent; in these the hyphae of the context form a denser tissue, about 0·25 mm. thick, with a narrow dense layer, about 20 μ thick, running beneath the hymenium, but discontinuous. The specimen attributed by Berkeley to *Hymenochaete crocata* is this thicker form.

Where the resupinate part shows superposed secondary growth, the latter consists of interwoven hyphae, not parallel to the surface, with narrow, dense, dark brown zones at different levels.

The setae are 56-80 μ long, 8-10 μ diameter, dark red brown, conical, acute, with a narrow central cavity extending nearly all, or part of, the length, and project 40-64 μ. On the secondary thickenings of the resupinate part, they may be 100 μ long.

Hymenochaete nigricans (Lév.) Bres. In Fungi of Ceylon, No. 610, Berkeley and Broome described *Hymenochaete strigosa* from Thwaites 977. The type in Herb. Kew is marked by Bresadola, " = *H. phaea* B. = *H. spadicea* B. & Br. = *H. villosa* (Lév.) Bres." *Hymenochaete spadicea* B. & Br. was described in Fungi of Ceylon No. 612; the type of this in Herb. Kew is marked " = *Hymenochaete villosa* (Lév.) Bres." Massee (Mon. Theleph.) listed *Stereum villosum* Lév. as a *Stereum*, citing a Javan specimen from Léveillé in Herb. Kew, but Miss Wakefield informed me that the specimen is really a *Hymenochaete*. In Kew Bulletin, 1915, p. 368, Miss Wakefield lists *Hymenochaete villosa* (Lév.) Bres., with the synonyms *H. strigosa*, *H. spadicea*, and *H. phaea*, citing Bresadola in Hedwigia, LI (1912), p. 323. In Ann. Myc., XIV (1915), p. 233, however, Bresadola refers all these species to *Hymenochaete nigricans* (Lév.) Bres.

According to Bresadola in Ann. Myc., VIII, p. 588, *Hymenochaete villosa* has setae, 29-45 x 4-7 μ.

The specimen of *Hymenochaete strigosa* in Herb. Peradeniya (Thwaites 977) has the habit of *tenuissima*, with a similar strigose, concentrically sulcate pileus, but its colour on both the upper and lower surface is deep purple-brown, almost black. The thickness of the pileus, omitting the dorsal strigae, is about 0·3 mm. The context is dense, black in section,

deep red brown by transmitted light, and composed of hyphae, more or less parallel to the surface, fused into a solid mass. The hyphae of the strigose layer vary from deep yellow-brown to purple-brown. The setae are conical, 36-56 x 6-8 μ, and project 12-30 μ.

In the type of *Hymenochaete spadicea* in Herb. Kew, the specimens are thinner. One is 0·2 mm. thick, omitting the dorsal strigose layer, deep chestnut brown above, purple-brown below, with the context dense and appearing black in section ; its setae project up to 32 μ. The other, similarly measured, is 0·1—0·15 mm. thick, yellow-brown above, dark-brown below, and does not appear black in section ; its setae are conical, up to 80 x 10 μ, and project up to 50 μ. The first of these is *Hymenochaete nigricans*, the second *Hymenochaete tenuissima*.

In general structure, *Hymenochaete nigricans* closely approaches *Hymenochaete tenuissima*, and it is sometimes difficult to decide whether a specimen is *Hymenochaete nigricans* or old *Hymenochaete tenuissima*. I have specimens of the former in which the thickness of the pileus is only 0·15 mm.

Hymenochaete barbata Massee. This species was described by Massee in Mon. Thelephoreae, p. 109, as " Latissime effusa, adnata, crassa ; margine obtusiusculo ; hymenio laete ferrugineo, ambitu pallescente ; setis conico-acuminatis, 80-140 x 12-17 μ ; sporae ellipsoideae, 4 x 2-2.5 μ." It was part of Thwaites 335, which was assigned to *Hymenochaete leonina* by Berkeley and Broome. Thwaites 335 was a mixture and contained *Hymenochaete tenuissima*, as well as the species described by Massee.

The specimens are totally resupinate, rufous brown, appearing blackish-brown owing to the large setae, tawny at the margin, which is slightly tumid. The thickness of the fructification varies from 0·25 to 0·6 mm., the thicker parts usually exhibiting two layers in the context. The context is composed of interwoven yellow-brown hyphae, with a dense red-brown basal layer of agglutinated hyphae which are more or less parallel to the substratum. Where the context shows two layers, these are separated by a similar red-brown layer. The surface, between the setae, consists of a palisade layer of yellow hyphae, 2-3 μ diameter, which taper irregularly to the apex. The setae are scattered, deep red-brown, elongated conical, slightly inflated below, with a narrow central cavity. Massee gave the dimensions of the setae as 80-140 x 12-17 μ. They are up to 220 μ long, 17 μ diameter, and project up to 150 μ. Apparently his measurements did not include the embedded part.

As already stated, Thwaites 335 contained this species and *Hymenochaete tenuissima*. The setae of *Hymenochaete barbata* are much longer

than those of *H. tenuissima*, and its structure differs from that of the resupinate parts of the latter.

Hymenochaete corrugata Lév. This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 617, from Thwaites 145, in part. The herbarium specimens vary in colour from purple-brown to greyish-brown ; they are cracked into small areolae, and the surface is somewhat nodular. The thickness varies from 50 μ to 200 μ, the thicker parts filling inequalities in the bark of the host, and the fungus merges somewhat indefinitely into the latter, without any differentiated basal layer. The context is composed of interwoven fused hyphae, definite regular hyphae being observable only in the cells of the bark, or where the fungus has filled up a crack. Setae occur at all levels from the base of the fructification, and are conical, or cylindric below becoming conical above, acute, 48-80 x 7-12 μ, exceptionally 32 x 7 μ, projecting 20-40 μ.

Fresh specimens of this species are purple grey with a tawny byssoid margin. On preservation in the herbarium they become brownish grey, with a pale brownish yellow margin. In these, which are on wood, the surface is not cracked.

Hymenochaete depallens B. & Br. This was described by Berkeley and Broome in Fungi of Ceylon, No. 616, from Thwaites 145 in part. It has not been collected again. The fungus is resupinate, effused, brownish grey, glabrous between the setae, thinning out to a brownish fawn, byssoid margin. It is 0·2-0·4 mm. thick, with the context loose and spongy, reddish brown, composed of thin-walled yellow-brown hyphae, 4 μ diameter, very loosely interwoven below, becoming somewhat denser above, the continuous superficial layer being about 20 μ thick. When the fungus is broken or cracked, the upper layer recurves or shrinks, and the contrast then between the glabrous pellicle and the fibrillose, red-brown, oblique sides of the fissure is very marked. The setae arise in the denser part of the context, some distance below the superficial layer, and are fusoid, sometimes curved above, 100-175 x 12-14 μ, projecting 50-100 μ.

Hymenochaete fuliginosa Lév. This was recorded for Ceylon by Berkeley from a specimen sent by Gardner (*Stereum fuliginosum* Fr.), and by Berkeley and Broome in Fungi of Ceylon from Thwaites 219.

Thwaites 219 grew on bark. It forms a purple-brown, effused fructification, with a rather broad, tawny brown margin. The thickness varies from 0·15-0·25 mm. It is composed of interwoven yellow-brown hyphae, more or less fused into a solid mass, but with individual hyphae visible here and there. There is no definite basal layer. The setae are situated in a single layer, and are scattered, conical, 36-60 x 6-9 μ, projecting

16-40 μ. This is evidently not the same as *Hymenochaete fuliginosa* (Pers.) Bres., of Burt's Thelephoraceae of North America, nor as *Hymenochaete fuliginosa* Lév., of Wakefield, Kew Bulletin, 1915, p. 368.

The Gardner specimen is quite different from the foregoing. It is resupinate, reddish purple-brown, varying in thickness from 0·15-0·3 mm. at points fairly close together. In the thinner parts, the fructification has a thin, light yellow zone of parallel hyphae overlying the substratum, with a deep red brown layer underlying the setae, and the setae are fasciculate, in groups of up to six. The setae are not branched, but merely arise close together in fascicles, their bases being often irregularly contracted and distorted. In the thicker parts, the context consists of fused interwoven hyphae, yellow-brown, sometimes interrupted by irregular, narrow, red-brown horizontal zones ; the setiferous layer is denser and appears red-brown in thick sections, but there is no definite red-brown layer underlying the setae. The setiferous layer may be stratose. The upper part of the context, immediately below the setiferous layer, contains numerous oval cavities. The setae on the thicker parts are frequently scattered ; they are conical, usually acute, 64-80 x 8 μ, and project up to 30 μ. This species does not appear to have been described. It may be known as *Hymenochaete lictor*. The setae are normal *Hymenochaete* setae, and consequently the fungus does not fall in *Veluticeps* Cooke.

Hymenochaete lictor n. sp. Resupinate, effused, reddish purple-brown, 0·15-0·3 mm. thick ; context of fused interwoven yellow-brown hyphae, sometimes with a zone of parallel hyphae overlying the substratum, sometimes interrupted by narrow red-brown zones, sometimes with a similar zone underlying the steae ; setae in a single layer, conical, usually acute, 64-80 x 8 μ, projecting up to 30 μ, usually grouped in fascicles of up to six.

Hymenochaete floridea B. & Br. This was described from Thwaites 366, which furnished two species, *Thelephora floridea* B. & Br., and *Hymenochaete floridea* B. & Br. The type of *Thelephora floridea* in Herb. Kew is *Hymenochaete*, and all the specimens of Thwaites 366 are the same. This species is fairly common at Hakgala, usually on the trunks of standing trees. It is resupinate, effused, forming purple-red patches extending for several centimetres. Old herbarium specimens are purple-brown. The fructification is up to 0·35 mm. thick, composed of fuscous yellow-brown hyphae, up to 4 μ diameter, more or less parallel to the substratum in the lower part, becoming erect and fused in the setiferous layer. The setae are conical, usually obtuse, sometimes verrucose, 50-72 x 6-8 μ, in a single layer, projecting 15-50 μ.

Hymenochaete pellicula B. & Br. Berkeley and Broome described this in Fungi of Ceylon, No. 990, as "Resupinata, effusa, tenuissima, a matrice hic illic secernibilis, rubiginoso-grisea, margine vix ullo vel tenerrimo." Massee stated that the setae were stout, acuminate, 30-35 x 10 μ, often clear purple by transmitted light, and the spores white, 6 x 4 μ. Massee cited specimens from Ceylon and the United States, but Burt does not mention it in his account of the North American species of *Hymenochaete*.

The type specimen is on bamboo, on which the fungus forms a reddish grey, thin, effused, separable layer. The setae are not evident to the naked eye, and appear as scattered black points under a magnification of forty diameters; they are deep yellow-brown, conical, 24-44 x 6-7 μ. The total thickness of the fructification is about 50 μ, about one-half being yellow-brown. The basal layer is hyaline, and the superficial layer is also hyaline and uneven. The setae do not, or scarcely, project, but are immersed in the irregular, hyaline superficial layer. Here and there it can be seen (in section) that the setae arise from yellow-brown hyphae, 2 μ diameter, but nearly all the yellow-brown layer appears to be disorganised. The basal and the superficial layers are composed of spherical or irregular hyaline cells, about 4 μ diameter, with very fine hyaline hyphae, about 0·5 μ diameter, forming a continuous tissue. The specimen does not appear to be normal.

Massee's statement that the setae are often clear purple may refer to the American specimen. Purple setae have not been found in the Ceylon example. Massee's figure of *Hymenochaete pellicula* does not represent the type.

Hymenochaete semistupposa n. sp. Resupinate, effused, seal-brown, with a broad rufous margin, up to 0·8 mm. thick; vertically fibrillose when broken. Basal layer compact, red-brown (in section), 0·1-0·2 mm. thick, of densely agglutinated hyphae parallel to the substratum; intermediate layer, 0·3-0.4 mm. thick, loose, of dark yellow-brown, somewhat distant hyphae running more or less vertically; upper layer compact, about 0·3 mm. thick, dense, of parallel vertical hyphae, sometimes obscurely stratose. Setae arising at all levels in the upper layer, crowded, fusoid, 40-80 x 6-8 μ, projecting 20-50 μ. On bark of fallen trees, Hakgala; No. 5627, etc., in Herb. Peradeniya.

Hymenochaete crocicreas B. & Br. Berkeley and Broome described this in Fungi of Ceylon, No. 615, as "crassa, resupinata, intus croceo-lateritia, matricem eodem colore tingens. On decayed wood." In Grevillea, VIII, 149, Cooke referred it to his new genus Veluticeps, stating that the hymenium had fascicles of hairs, very short and conical, about 0·05 mm. long. Massee, in his Monograph of the Thelephoreae, stated

that there was no specimen in Herb. Berk., and repeated the original description There is a very small fragment in Herb. Kew now, *ex* Herb. Cooke.

Patouillard (Bull. Soc. Myc. France, XXXI, 77) redescribed this species from specimens from Tonkin. He stated that its real affinities were with the genus *Porogramme* where it should be placed next to *Porogramme lateritia*, and named it *Porogramme crocicreas* (B. & Br.) Pat.

Lloyd (Myco. Notes, VII, p. 1232) records that he receives abundance of *Hymenochaete crocicreas* from Malay and the Philippines. He states that it is not a good *Hymenochaete*, for the setae are not typical of that genus but tend rather towards metuloids ; they are coloured at the base, but hyaline with thickened walls above. Lloyd has examined Cesati's specimen of *Merulius crocicreas*, and finds that the latter is a *Grammothele* : he suggests that the Tonkin specimens are *Merulius crocicreas* Cesati, not *Hymenochaete crocicreas* B. & Br.

Herb. Peradeniya has about 16 sq. cms. of Thwaites 658, the type of *Hymenochaete crocicreas*. The fungus is resupinate, effused, even, reddish grey, hard, cracked (but perhaps in cutting off the specimen). It is up to 1·25 mm. thick, internally deep red, stratose, and somewhat friable. To the naked eye it appears smooth, but when magnified is seen to be covered with minute scattered projections. The hyphae of the context are vertically parallel, 4 μ diameter, orange-red, readily breaking up into short lengths. The older hyphae have solid contents, and the tissue breaks, when cut, like some resinous material. The projections are cylindrical fascicles of hyphae, about 30 μ diameter, rounded above, and projecting about 20 μ above the surface. They are orange-red or red-brown, and consequently are strongly contrasted against the yellow-brown hyphae of the general surface. Except in colour, the hyphae of these fascicles do not differ in any marked degree from the surrounding hyphae of the stroma. It is scarcely possible to regard them as setae or metuloids.

It would appear quite probable that *Hymenochaete crocicreas* and *Merulius crocicreas* are the same species, the projections of the former being the first elements of the pore walls of the latter. A similar development of pore walls from isolated fascicles occurs in *Poria Ravenalae*. Patouillard states that the " emergences " of the Tonkin specimen are sometimes scattered without any definite order, sometimes arranged in lines and confluent and forming minute pores. The hyphae of the stroma of *Hymenochaete crocicreas* are exactly the same as those of the old pore walls of *Poria epimiltina*, and it might be worth while considering whether the former is not a sterile form of the latter.

The type specimen of *Hymenochaete crocicreas* grew on a palm stem, probably coconut. The fungus has not been collected again in Ceylon.

Hymenochaete dendroidea B. & Br. This was described by Berkeley and Broome in Fungi of Ceylon, No. 620, from Thwaites 266. It was attributed to " B. & C.", and reference was made to specimens from Venezuela. It was not described with the other Venezuelan fungi in Berkeley and Curtis, Fungi Cubenses, and there is little doubt that, as in other similar instances in the Fungi of Ceylon, the description was drawn up from the Ceylon specimens. It is the well-known and much disputed fungus which grows on the lower surface of *Fomes applanatus*. It is not a *Hymenochaete*. Cooke, in Grevillea, VIII, p. 150, transferred it to *Thelephora*. Lloyd, Myco. Notes, No. 39, p. 539, referred it to *Sebacina*, and later, Myco. Notes, No. 62, p. 917, to *Institale*, stating that Bourdot has shown that it bears spores directly on the hyphae. I have not found spores in it, other than those of *Fomes applanatus* which have fallen from the host fungus, and the conidia of *Hypomyces chrysostomus* B. & Br., which is parasitic on the *Thelephora*. The mixture was named *Reticularia apiospora* B. & Br. (see Ann. Perad., V, p. 279).

Hymenochaete dura B. & C. This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 613, from Thwaites 546. The specimen in Herb. Kew is marked by Thwaites, 546 and 665, with the note, "sent before." It is on *Oncosperma*, and, from the specimens in Herb. Peradeniya, it is Thwaites 665. The fungus forms thick, spongy, red-brown stromata, either pulvinate, up to 5 mm. diameter, or confluent in large patches. The stromata are composed of loosely interwoven hyphae, with a thin, continuous, glabrous, outer layer on the smaller examples. The hyphae are 2-3 μ diameter, yellow-brown, septate, fairly regular, with thin or slightly thickened walls ; they bear spinulose, spore-like, oval bodies, 3·5 x 2·5 μ, each arising just below a septum, and numerous irregular crystals. There is nothing to indicate that this is a *Hymenochaete*. It appear to be a similar species to Thwaites 544, which is referred to *Septobasidium Merrillii* by Bresadola.

Hymenochaete ferruginea Massee. Massee, in Mon. Thelephoreae, p. 103, referred *Stereum ferrugineum* Fr. to *Hymenochaete*, and cited Ceylon as a locality. There is no Ceylon specimen under *Hymenochaete ferruginea* in Herb. Kew. *Stereum ferrugineum* Fr. was recorded for Ceylon by Cesati, with a query and the note "unicum individuum, neque optimum perfecto." Massee's record was probably taken from Saccardo. Lloyd, who has examined Cesati's herbarium, states that his specimen of *Stereum ferrugineum* is surely not that species, but it is not clear whether his note refers to Beccari's Ceylon collection. Until further evidence is available, this name should be deleted from the Ceylon list.

Hymenochaete Mougeotii (Fr.) Massee. In Fungi of Ceylon, No.624, Berkeley and Broome recorded *Corticium Mougeotii* Fr. Massee transferred this species to *Hymenochaete*. No Thwaites number was cited for the Ceylon specimen, and there is no Ceylon specimen under this name in Herb. Kew. Massee did not give Ceylon as a locality for this species, and hence, as he generally took his localities from the named specimens on the herbarium sheets, it may be deduced that there was no Ceylon specimen in Herb. Kew at the time he wrote. The name should be deleted from the Ceylon list.

ALEURODISCUS

Corticium Peradeniae B. & Br., Fungi of Ceylon, No. 629. This is an *Aleurodiscus*, which has been re-described by von Höhnel and Litschauer as *Aleurodiscus Peradeniae* in Beitrage zur Kenntniss der Corticieen, III, p. 16. *Aleurodiscus javanicus* P. Henn. is the same species. See Ann. Perad., IV, p 411.

Aleurodiscus scandens Petch, n. sp. Effused, indefinite, margin feebly byssoid, at first white or cream-coloured, sterile parts remaining white and becoming more or less glabrous, fertile parts yellow, pruinose, general thickness 60-100 μ here and there forming cushions up to 0·5 mm. thick ; in the thicker parts, composed of somewhat loosely interwoven hyaline hyphae, with denser basal and hymenial layers, the latter consisting chiefly of dendrophyses ; in the thinner parts loose and friable, composed of erect hyphae 4 μ diameter, passing into dendrophyses above ; dendrophyses 2-4 μ diameter below, simple or branched, dividing above into a head of spreading conical spines, up to 4 μ long, 0·5-1 μ diameter ; basidia not seen. On dead twigs and leaves, some distance from the ground, Hakgala, January 1914 ; No. 4585.

This is one of a group of species, common in up-country jungles, which fasten together dead or living twigs, or small branches, by means of cushions of hyphae, and so form, when the twigs and branches die, large tangles suspended several feet above the ground. *Panus melanophyllus* has the same habit.

CORTICIUM

Corticium salmonicolor B. & Br., Fungi of Ceylon, No. 640. This is the now well-known fungus which causes the disease known as Pink Disease in the tropics. It was described again by Zimmermann in Java as *Corticium javanicum* Zimm. In compiling vol. XVI of the Sylloge Fungorum, Saccardo and Sydow changed *Aleurodiscus javanicus* P. Henn. to *Corticium javanicum* (P. Henn.) Sacc. & Syd., an alteration which was invalid, owing to the prior existence of *Corticium javanicum*

Zimm. Subsequently, when *Corticium javanicum* Zimm. came to be included, they changed the latter name to *Corticium Zimmermanni* Sacc. & Syd.

Thwaites mixed his specimens of *Corticium salmonicolor* (Thwaites 4) with *Corticium Peradeniae* (Thwaites 199). Berkeley and Broome detected the error, and described the two species correctly, but they did not separate the specimens. Hence Massee's re-description of *Corticium salmonicolor* in Mon. Thelephoreae relates chiefly to *Corticium Peradeniae.*

Corticium tristiculum B. & Br. This was described by Berkeley and Broome from Thwaites 994. Massee in Mon. Thelephoreae transferred it to *Hymenochaete*, but altered the name to *tristiusculum.* Patouillard, in Philippine Journal of Science, vol. X, Sec. C, Botany, p. 87, described the same species as *Duportella velutina*, the type of a new genus *Duportella.*

The fungus is resupinate, seal brown with a paler greyish brown margin, minutely velvety, becoming glaucous when old and cracking irregularly. The thickness of the fructification is 0·1—0·2 mm. The basal layer is thin and compact, composed of hyphae parallel to the substratum. Above that, the context consists of loosely interwoven, stout, fuliginous yellow-brown hyphae which curve upwards into the hymenium. The latter is about 0·04 mm. thick, and consists of a close palisade layer of paraphyses, about 3 μ diameter, with obtuse tips. Occasionally, these paraphyses expand irregularly above to a diameter of 5 μ, and they then somewhat resemble a *Hymenochaete* seta, though comparatively thin-walled. In general, however, the paraphyses are merely the tips of the hyphae, and are not differentiated. They do not project. Among the paraphyses are thin-walled, inflated cystidia with hyaline contents, irregularly fusoid or conoid, sometimes more or less truncate at the base, 40—64 x 16 μ. These arise from the hyphae, and may be situated at any depth in the fructification.

This species does not possess *Hymenochaete* setae and cannot be placed in that genus. The structure of the hymenium recalls that of *Stereum percome.* If Patouillard's genus is not accepted, the fungus should remain in *Corticium.*

Corticium rhabarbarinum B. & Br. Thwaites collected two species in the south of the Island in July 1868, which formed his numbers 656 and 657; he marked the latter, "compare with 656." Berkeley and Broome named the first of these *Corticium reticulatum* (Fungi of Ceylon, No. 628), and the second, *Corticium rhabarbarinum* (Fungi of Ceylon, No. 627). They stated that the two were undoubtedly closely allied, but it would appear from their descriptions that their specimens were mixed. In 1915, the type of *Corticium rhabarbarinum* in Herb. Kew contained

two pieces of *Corticium rhabarbarinum* and two of *Corticium reticulatum*. Berkeley and Broome described both as arising from radiating fibres, but that is true only of *Corticium reticulatum*.

The name *Corticium rhabarbarinum* had previously been applied by Berkeley to a specimen from New Zealand. Cooke, in Grevillea, VIII (1880), p. 148, referred the New Zealand species to *Hymenochaete*, as *Hymenochaete rhabarbarina* Cke., stating that the setae were subconical, 28—30 x 8—9 μ. Ten years later, Massee referred the Ceylon specimen to *Hymenochaete*, as *Hymenochaete rhabarbarina* Massee, citing only the Ceylon record for his type, but giving Ceylon and New Zealand as localities. His description evidently contains details of both the Ceylon specimens and of the New Zealand specimen, i. e., it is a compound of *Hymenochaete rhabarbarina* Cke., *Corticium rhabarbarinum* B. & Br., and *Corticium reticulatum* B. & Br. Miss Wakefield. in Kew Bulletin, 1915, p. 370, re-described the Ceylon *Corticium rhabarbarinum* as *Stereum rhabarbarinum* Wakefield.

Corticium reticulatum B. & Br. was said to be antedated by *Corticium reticulatum* Fr., a name which appears to have vanished. Hence the former name was changed in Sylloge Fungorum, VI (1888) to *Corticium marescalchianum* Manc. & Sacc.; and Massee, in Mon. Thelephoreae (1890), replaced it by *Corticium flavo-virens* Mass. The fungus is a *Septobasidium*, and in Bull. Soc. Myc. France, XXIV (1908), p. 2, Patouillard listed it as *Septobasidium reticulatum* (B. & Br.) Pat.

Stereum rhababarinum Wakefield is a thick, hard, resupinate species which cracks in rather distant lines, chiefly transversely. Berkeley and Broome did not see any difference in colour between this and *Corticium reticulatum*, but stated that the hymenium was "rhabarbarinum" in both. Miss Wakefield describes that of *Stereum rhabarbarinum* as cinnamon, but there is a distinct greenish yellow tinge in certain lights. The hymenium is pruinose. The margin is sub-vertical, glabrous, and dark brown to black. The context, in mass, is pale purple-brown. In sections, it is seen to be closely stratose, and composed of yellow-brown hyphae fused together so that the individual hyphaeare indistinguishable. The hymenium contains aculeate paraphyses, obtuse, cylindrical or inflated above, 15-20 x 5 μ. At the base, next the substratum, red-brown resinous masses may be present, both in the stroma and in the host cells, and here and there a red-brown seta arises from the basal layer to a height of about 80 μ.

I have a recent collection which appears to be an old stage of this species. The fructification is pruinose and greyish brown, or purple-brown where the outer layer has weathered off. It is 1·5 mm. thick, cracked in lines at right angles, but chiefly transversely, with a subver-

tical, black, glabrous margin. Internally it is stratose, and of the same structure as the type of *Stereum rhabarbarinum*, but the colour of the tissue is deeper, because of the presence of large quantities of the red-brown resinous substance, which often lies in definite zones between the successive strata. But it differs from the type in containing numerous red-brown setae, which can be detected with a hand lens on a section of the stroma. These setae are 100-375 x 8-12 μ, cylindric, tapering at each end, somewhat flexuose. They arise at all levels in the stroma, not in definite rows, and do not bear any necessary relation to the strata, a single seta running through several strata. They are all completely embedded. It was thought that these might be resinous inclusions; but on heating a section of the fungus in concentrated nitric acid the setae persist, while the red-brown resinous substance disappears. The setae have a narrow central cavity, and are similar to normal *Hymenochaete* setae. They differ from the latter in that they are all embedded, and do not arise in association with the successive strata of the fructification.

Obviously it would appear at first sight that this recent collection is distinguished from *Stereum rhabarbarinum* by the presence of setae, and must be a different species. But although sections of the type of *Stereum rhabarbarinum*, in general, do not show any setae, they do occur occasionally, arising from the base of the stroma. It is possible that, in that position, they have not been distinguished from the red-brown resinous deposits which are often situated in pockets at the base of the stroma. The two fungi resemble one another so closely in other respects, that it would appear probable that they are the same species, the development of these internal setae occurring only when the fructification is old.

Corticium flavo-rubens B. & Br., Fungi of Ceylon, No. 647. As stated in Ann. Perad., VI, p. 157, this species also furnished the record of *Stereum sulphureum* Fr., and is no doubt the basis of the record of *Corticium sulphureum* Fr. and *Stereum strumosum* Fr., for Ceylon.

As previously described, this species forms small patches, usually irregularly oval, up to 8 mm. in diameter and 0·5 mm. thick, powdery, usually with a definite rounded tomentose margin. These are at first bright yellow, but become orange-yellow owing to the development of a large number of minute, red-brown bodies on or near the surface. Internally they are white, composed of interwoven hyphae, 1-2 μ diameter, encrusted with calcium oxalate. The red-brown bodies, which occur in the upper layer, are oval or irregular, amorphous, up to 24 x 20 μ. Basidia have been found only in a very early stage, when the fungus is a thin, powdery, yellow patch on the bark. In this stage, there is practi-

cally no basal layer, the basidia being perpendicular to the bark, mixed with scattered, erect, branched, yellow hyphae, 1·5 μ diameter, sometimes loosely interwoven. The basidia are somewhat scattered, oblongo-clavate, 60-100 x 24-32 μ, four-spored, the sterigmata being up to 24 μ long, 5 μ diameter below, attenuated upwards, narrow flask-shaped. The spores are globose, 26-32 μ diameter, or pyriform, pedicellate, with coarsely granular contents, and often adhering in fours.

Corticium suffultum B. & Br., Fungi of Ceylon, No. 651. Berkeley and Broome stated that this was analogous to *Thelephora pedicellata*. It is a *Septobasidium*, and has been described by Patouillard in Bull. Soc. Myc. France, XXXVI, p. 175, as *Septobasidium leucostemon*, the name *Septobasidium suffultum* having already been employed for *Thelephora suffulta* B. & Br.

Corticium modestum B. & Br. This was described by Berkeley and Broome in Fungi of Ceylon, No. 626, from Thwaites 992. Massee, in Mon. Thelephoreae, transferred it to *Hymenochaete*. The colour was said to be yellowish grey, with a yellowish margin. The specimens are now brownish grey with a paler margin. It has not been collected again. It is resupinate, forming at first circular patches which ultimately coalesce, sometimes zoned, separable from the substratum, with the dorsal surface matted silky tomentose. The total thickness is about 0·2 mm. The dorsal layer consists of loosely interwoven, pale yellow-brown hyphae more or less parallel to the substratum, and merges without any definite demarcation into the denser subhymenial layer. Gloeocystidia, about 5 μ diameter, curve upwards from the subhymenial layer, and may project about 12 μ, their apices being minutely verrucose and only slightly inflated. This is not a *Hymenochaete*, but a *Stereum* (*Lloydella*), and it will stand as *Stereum* (*Lloydella*) *modestum*.

Corticium alopecinum B. & Br., Fungi of Ceylon, No. 631. This species grew on bark, from which it was evidently readily separable. The specimens, Thwaites 1034, in Herb. Peradeniya, have, for the most part, been peeled off the substratum. They show various stages of development. In places, the fungus consists merely of a very thin, red-brown, continuous membrane, formed by loosely interwoven, yellow-brown hyphae, agglutinated into a continuous sheet. On this sheet are situated effused, rather loose and spongy, flat masses of yellow-brown hyphae; and in the fully-developed parts these are covered by a thin grey layer which can be peeled off from the spongy context. The fully-developed parts are up to 0·5 mm. thick. The basal layer is a very thin continuous film. The context is loose, composed of regular, septate, branched, yellow-brown hyphae, which divide above into numerous short, hyaline, irregular branches. The upper, slightly denser, hymenial

layer is composed of these branches, with numerous globose, yellow-brown bodies, 11-13 μ diameter, or oval, 12 x 10 μ. These are evidently probasidia; and the fungus is a *Septobasidium*, which may stand as *Septobasidium alopecinum* (B. & Br.).

Corticium murinum B. & Br., Fungi of Ceylon, No. 635 was transferred to *Coniophora* by Massee. It is a *Septobasidium*, which may be known as *Septobasidium murinum* (B. & Br.).

Corticium muscigenum B. & Br., Fungi of Ceylon, No. 638. This species is not uncommon at Hakgala. It grows on the old decaying bark of living trees. The mycelium is white, and runs in a network of strands, up to 0·5 mm. diameter, among the bark scales, here and there producing white byssoid patches on which the fructification is developed. The mature fructification is usually more or less circular, often irregularly angular, 1-2 cm. diameter, fawn-coloured, with a white margin at first, pruinose, soft and spongy, up to 1·5 mm. thick. Internally it is white, or zoned, white and pale brown, soft and friable. The basal layer is thin, felted tomentose, white to brown when viewed from below, yellow to yellow-brown in section. The context is composed of loosely interwoven, thin-walled, hyaline hyphae, 1-3 μ diameter, and contains numerous small, spherical crystals of calcium oxalate. The basidia are clavate, 4-6 μ diameter, four-spored, with slender sterigmata. The spores are oval, hyaline, minutely spinulose, 5-6 x 3-4 μ. It has no resemblance to *Aleurodiscus Peradeniae*, *Peniophora sparsa*, or *Corticium scariosum*, to which Berkeley and Broome compared it.

Corticium scariosum B. & Br., Fungi of Ceylon, No. 548. This was described as " Ochroleucum scariosum, hymenio glabro e mycelio arachnoideo oriundo, demum subsecernibile (No. 548). On dead wood. Forming thin patches which at first consist of arachnoid fibres, which after a time are partially collected together and run over the first in the form of thin threads. Though somewhat resembling *C. Peradeniae* and *salmonicolor* there is a material difference." Massee stated that the spores were globose, 7-8 μ diameter.

The specimens on dead wood are effused, thin patches, powdery in some parts, glabrous in others, cracked, pale ochraceous. At the margin there may be a thin byssoid film, traversed by a few definite strands. The thickness of the fructification is about 0·1 mm. The basal layer is an extremely thin weft of hyaline hyphae, 1-5 μ diameter. The context is composed of the same hyphae, densely interwoven and enclosing numerous crystals of calcium oxalate. The surface consists of a layer of cuboid cells about 10 μ deep. Basidia were not found.

In Herb. Peradeniya, there are other specimens under Thwaites 548, on bark. These consist of a coarse byssoid layer of hyphae, extend-

ing indefinitely, probably white when fresh. The hyphae are up to 8 μ diameter. This appears to be a different species.

Corticium scariosum does not bear any resemblance to *C. Peradeniae*, and very little to *C. salmonicolor*.

Corticium caeruleum Fr. Recorded for Ceylon in Fungi of Ceylon, No. 642. Common at Hakgala. Ceylon specimens are deep Prussian blue, becoming almost black in the older parts, sometimes with a narrow white margin. Thickness 0·15 mm. Basal layer, loose, fuscous, composed of pale yellow-brown hyphae, 4 μ diameter; intermediate tissue white, of hyaline, thick-walled hyphae, up to 5 μ diameter; sub-hymenial tissue blue. The basidia do not appear to exceed 30 μ in length.

Corticium simulans B. & Br. Berkeley and Broome described this as "Molle, fulvum, e strato albo floccoso membranaceo oriundum; hymenio laevissimo (No. 340). Running over mosses. At first sight resembling *Merulius Corium*. Spores subelliptic, .0003 long." In Ann. Myc., IX (1911), p. 271, Bresadola recorded a specimen from Africa as *Hymenochaete simulans* (Berk.) Bres., citing *Corticium simulans* B. & Br. as a synonym. He stated it had brown setae, 80-100 x 7-9 μ, and hyaline spores, 7-10x4-5 μ. von Höhnel and Litschauer had previously (1907) referred this species to *Hymenochaete*, having apparently based their opinion on the American fungus which Berkeley recorded under the same name. The Ceylon specimen, however, is not a *Hymenochaete*, and the type in Herb. Kew bears a note to that effect by Lloyd, with the spore measurement, 7 x 3 μ.

The specimen in Herb. Peradeniya consist of a membranous film, deep ochraceous, overrunning mosses, here and there containing evident strands, and sometimes appearing thicker and horny. Where the hymenium is developed, the fungus is glabrous, waxy, red-brown, and very fragile. The thickness is 0·1-0·2 mm. The texture of the stroma is compact, except at the extreme base. The basal hyphae are up to 4 μ diameter, thin-walled. The basal half of the stroma is hyaline in section, the upper part yellow-brown. The basidia are clavate, 24 x 4 μ.

Corticium ambiens B. & Br., Fungi of Ceylon, No.649. Berkeley and Broome described this species as "candido", Massee, as pure white with a slight tinge of ochre or pink. The part of Thwaites' specimen in Herb. Peradeniya is now pale ochraceous, with here and there a narrow, white, byssoid margin, effused, very smooth but not shining. Where it is cracked, the exposed white, basal layer appears chalky. The thickness is about 0·3 mm. The basal layer is white, and contains large numbers of irregular masses of calcium oxalate. The intermediate tissue is compact, composed of irregular spiny hyphae, 2 μ diameter, agglutinated so that the individual hyphae are almost indistinguishable.

The basidia are cylindric, 4 μ diameter. This does not appear to be related to *Stereum duriusculum*, though it resembles the latter in some respects.

Corticium emplastrum B. & Br., Fungi of Ceylon, No 632. This was described as " Effusum tenue, substrato niveo marginem angustum efformante ; hymenio glaberrimo alutaceo rimoso. Forming little confluent patches about half an inch wide ; margin very narrow, byssoid ; the whole looking like a little plaister." It is a common species, frequently occurring on dead branches of *Hevea*. It is much more extensive than in the type, and often covers an area six or eight inches long, and four to six inches wide. The fructification is at first white, somewhat fibrillose, becoming glabrous and porcellanous, and changing colour on the older parts to yellow-brown, then red-brown, somewhat irregularly so that it appears stained. The thickness is about 0·4 mm. The context is white, and composed of loosely interwoven, irregular, hyaline hyphae, 2-3 μ diameter. The surface layer is about 16 μ thick, yellow-brown in section, and composed of hyphae more or less parallel to the surface, agglutinated into a solid layer, with an amorphous yellow-brown deposit. The surface layer cracks, and exposes the white internal tissue. No hymenium has been observed in this species.

Corticium albovirescens Petch, n. sp. Effused, spreading indefinitely, membranous, white, becoming glabrous, shining, and porcelain-like, developing here and there fairly large greenish-grey hymenial patches ; total thickness up to 0·3 mm. ; basal layer of hyaline hyphae, 2-3 μ diameter ; subhymenial hyphae with brown or olive contents ; basidia oblong or oblong-oval, 26 x 10 μ, with four slender sterigmata up to 6 μ long, accompanied by somewhat irregular paraphyses, 4 μ diameter, sometimes forked at the apex ; spores hyaline, minutely warted, narrow-oval, inequilateral, 8-10 x 4 μ. On dead wood, Hakgala, April 1919 ; No. 5960.

Corticium cacaoicolor Petch, n. sp. Effused, indefinite, pale chocolate, glabrous, waxy, with a broad greyish white, sometimes pruinose, margin ; 0·1-0·2 mm. thick, the basal layer, about one-third the total thickness, hyaline, of loosely interwoven hyphae, the upper part compact, subtranslucent, pale yellow in section ; basidia 5 μ diameter, sterigmata 3 μ long, spores hyaline, oblong-oval, 7 x 3 μ. On a dead branch, Peradeniya June, 1915 ; No. 4697.

Corticium flavocarneum Petch, n. sp. Effused ; at first ochraceous yellow, becoming pinkish ochraceous, with a broad, irregular, byssoid margin, turning purplish where bruised ; old herbarium specimens salmon pink, with a white margin ; pulverulent, soft ; 0·1 mm. thick, context of loosely interwoven, hyaline, regular hyphae, 3-4 μ diameter below,

curving upwards and branching at a wide angle, the branches terminating in clusters of clavate basidia and paraphyses which form a continuous hymenium ; basidia clavate, 5-6 μ diameter ; paraphyses 3-4 μ diameter, minutely spinulose ; spores hyaline, oval, minutely spinulose, 6-8 x 3-5 μ. On a dead branch, Hakgala, April 1915 ; No. 4672.

Corticium corneum Petch, n. sp. Resupinate, effused, glabrous, horny, dull orange ; in section white below, dull orange and translucent above ; thickness 0·2-0·4 mm. ; lower part, up to 0·1 mm. thick, of loosely interwoven, hyaline hyphae, upper part of vertically agglutinated hyphae, constituting the greater part of the stroma, with irregularly spherical crystals of calcium oxalate scattered throughout ; basidia 4 μ diameter, cylindric, expanding slightly above, sterigmata conical, very short ; spores hyaline, narrow-oval, inequilateral, minutely warted, 7-9 x 4-6 μ. On wood, Peradeniya, Nov. 9, 1915 ; No. 4778.

Corticium farctum Petch, n. sp. Effused, white, becoming pale ochraceous, with white sterile patches, and, at first, a broad, white, pruinose margin, smooth, waxy, spreading in patches up to 20 cm. long and 15 cm. broad ; fructification 0·12 mm. thick, lower half hyaline in section, upper half pale yellow ; basal layer thin, yellow, or wanting ; lower half composed of loosely interwoven, somewhat rigid, hyaline, thick-walled or solid, refringent hyphae, 1·5 μ diameter ; upper half compact, of agglutinated hyphae ; basidia ovoid or pyriform, attenuated below into a stalk, up to 18 μ long, 6-8 μ diameter, four-spored ; sterigmata short, about 2 μ ; spores oval, inequilateral, hyaline, 8 x 3 μ. On dead coriaceous leaves, Gikiyanakande, June 1916 ; No. 5661. The hyaline hyphae stain purple-brown with iodine.

Corticium (Gloeocystidium) endovirgatum Petch, n. sp. Resupinate, effused, pale brown or fawn, with a paler byssoid margin, pruinose, up to 0·9 mm. thick ; lower part, up to 0·7 mm. thick, loose and spongy, composed of loosely interwoven, slender, hyaline hyphae, separated from the upper part by a narrow, red-brown zone, about 16 μ thick, composed of parallel hyphae ; upper part composed of loosely interwoven, hyaline hyphae for about half its thickness, passing into the compact hymenial layer ; upper layer and hymenium traversed by numerous, irregular gloeocystidia, 6-8 μ diameter, with brown or yellow-brown contents ; spores hyaline, oval, 5 x 3 μ. On wood, Henaratgoda, August 1916 ; No. 5212.

Corticium comedens Fr. This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 652, from Thwaites 623. They stated that it presented nothing more than a very thin, pulverulent hymenium. Thwaites 631 was said to differ in being a purer white.

In Thwaites 623, the fungus develops beneath the outer layer of the bark, which splits and recurves in more or less triangular scales, exposing irregular patches, up to 7 x 4 mm. These patches are greyish white and powdery. They consist of a very thin film of irregular spinulose hyphae, 1-2 μ diameter, which bear minute, hyaline spores, about 1 μ diameter, or 1·5 x 1 μ. A few spinulose hypha tips, up to 6 μ long, may stand erect. No. 631 is the same, but the patches are smaller, about 1 mm. diameter. There is nothing which would indicate that this is a *Corticium*, and the name should be deleted from the Ceylon list.

Corticium incarnatum Fr. This was recorded for Ceylon by Berkeley and Broome from Thwaites 986, the specimen being said to be parasitic on a byssoid *Sphaeria*. It is not possible to say what it is from the herbarium specimens. It does not appear to be parasitic on a *Sphaeria*. The stroma contains vertical red-brown structures which appear to be part of the host plant.

Corticium chlorascens B. & Br. Massee, in Mon. Thelephoreae, stated that this was an immature byssoid *Nectria*. It is an immature Hypocreaceous fungus, but apparently *Hypocrea*.

Corticium peroxydatum B. & Br., Fungi of Ceylon, No. 633. Massee transferred this to *Coniophora*. As previously stated (Ann. Perad., VI, p. 157), it is an immature *Hypoxylon*.

Corticium calceum Fr. This was recorded for Ceylon by Berkeley and Broome from Thwaites 329 in part. That Thwaites's number provided *Stereum duriusculum* B. & Br. There is no Ceylon specimen included under *Corticium calceum* in Herb. Kew.

Corticium tenuissimum B. & Br., Fungi of Ceylon, No. 637. This was described as "suborbiculare tenuissimum subglaucum, margine albo annulo rufo cincto (No. 998)." Massee (Mon. Thelephoreae) added that the colour was silver grey, and that the spores were oblongo-ellipsoid, 8 x 6 μ. The specimen in Herb. Peradeniya bears a note by Thwaites, "disk pale grey, blue when fresh." The stromata are about 5 mm. diameter, usually circular, brownish grey, or dark grey with a paler margin, with sometimes an intermediate yellowish zone, glabrous, about 100 μ thick in the centre, 40 μ thick elsewhere. Sections show that it is an immature lichen, the thallus containing alga cells in chains.

Corticium hypochnoideum B. & Br. This, described in Fungi of Ceylon, No. 641, was attributed to "B. & C." It was said to be "Pusillum stellato-orbiculare rubrum, margine elevato; hymenio demum atro-vinoso. Sometimes erumpent, sometimes superficial, with a narrow white border. Analogous to *Stereum ruberrimum*." Massee listed it as a doubtful species. The fungus is erumpent, oval, 1·5 x 0·7 mm., or

circular, about 1 mm. diameter, dark crimson, or purplish red. The white pulverulent border consists partly of fungus tissue and partly of fragments of bark. Sections show that it is undoubtedly an immature ascomycete. Thwaites marked the part of the gathering which he kept " ? *Stictis*."

ASTEROSTROMA

Asterostroma apalum (B. & Br.) Massee. This, the type species of the genus *Asterostroma*, was described by Berkeley and Broome as *Corticium apalum* in Fungi of Ceylon, No. 648. They stated that it was nearly allied to *Corticium Habgallae*, a white, subgelatinous *Peniophora* to which it has no resemblance. When fresh, it is yellow-brown at first, with a white byssoid margin, becoming pinkish buff when mature, powdery, soft. The fructification is about 0·3 mm. thick, internally loose, spongy, and pale pinkish brown. It is composed almost entirely of pale yellow-brown, stellate hyphae, with arms, 20-36 x 3 μ, attenuated outwards, sometimes forked, the arms of each star being approximately equal. In the surface layer some have arms only 8 x 2 μ. The basidia are oval or subglobose, four-spored,4-8 x 3-6 μ, with conical sterigmata, 2 μ long. The spores are hyaline, fusoid, 6 x 1·5 μ.

Asterostroma degenerans Bres. This was detected by Bresadola in *Hymenochaete depallens*, Thwaites 145, in Herb. Kew, and was described by him in Ann. Myc., XVIII (1920), p. 49. The same mixture occurs in the corresponding specimen in Herb. Peradeniya. The fungus is purple-brown, here and there with a greyish superficial film, farinose, with numerous, dark brown, projecting setae. The context is loose, and reddish brown. The fructification is about 0·2 mm. thick, or in places stratose and up to 0·7 mm. thick. The setae are deep yellow-brown, 80—130 x 12—14 μ, with sub-horizontal, stellate bases of usually three rays, each up to 50 μ long, 5 μ diameter, tapering outwards. The stellate bases of the setae interlace, and, with a few hyaline hyphae, form a superficial layer about 40 μ thick. Internally the structure is loose, and consists of stellate hyphae, pale yellow-brown, with numerous rigid, spreading rays, about 50 μ long, 3—5 μ diameter, sometimes forked. Sometimes two stellate clusters are united by a short isthmus.

Massee founded the genus *Asterostroma* on *Corticium apalum* B. & Br. The latter is a *Corticium* with stellate hyphae in the context. In the present species, the stellate hyphae are of two kinds, the longer branches of the larger projecting above the surface. This species is consequently a *Hymenochaete* with stellate hyphae in the context. Logically it should be placed in a new genus.

PENIOPHORA

Peniophora Habgallae (B. & Br.) Cooke. Berkeley and Broome described this in Fungi of Ceylon, No. 645, as *Corticium Habgallae*. Cooke transferred it to *Peniophora* in Grevillea, VIII, p. 20, and gave a re-constructed figure of it in Mycographia. It has occurred during the last sixteen years on dead branches of *Cinnamomum Camphora* at Hakgala. Neither the published figure nor the descriptions give any idea of the fungus when fresh. Berkeley and Broome stated that it was elevated on one side, and hence Massee considered that it formed a transition from the truly resupinate to the reflexed species, but that appearance must have been the result of drying.

When fresh, the fungus is pezizoid, circular or oval, regular or somewhat lobed, up to 1·5 cm. diameter, the upper surface plane or undulating, white, or pallid with a white margin; thickness up to 3 mm.; externally white, slightly tomentose, rounded and contracted below and centrally attached; fragile when fresh; shrinking when dry to a thin disc, 0·5—1mm. thick. Cortex at base and sides 0·1 mm. thick, white, fleshy; internal tissue subgelatinous. Hymenium about 0.15 mm. thick; cystidia hyaline, flask-shaped or conical, wall slightly thickened, encrusted, 80—100 μ high, 14—20 μ diameter below, projecting up to 66 μ; basidia clavate, up to 18 μ diameter above, four-spored; sterigmata stout, conical, about 6 μ high; spores oval, smooth, hyaline, 16—21 x 12—14 μ.

Peniophora lilacina (B. & Br.) Massee. This was described by Berkeley and Broome as *Corticium lilacinum*, Fungi of Ceylon, No. 634. The colour was said to be "e lilacino pallescens, margine albo tomentose." The specimens are now purple-brown. They are resupinate, plane or tuberculate, sometimes with coarsely tomentose, marginal areas. They are up to 0·8 mm. thick, compact and brownish white internally. The extreme basal layer is red-brown to yellow-brown, translucent, about 50 μ thick, composed of agglutinated hyphae, parallel to the substratum. The intermediate tissue is composed of irregular, hyaline, thick-walled hyphae, more or less vertical. The hymenium is brown in section. The cystidia arise at all depths, from stout hyphae, 8 μ diameter, which traverse the context subvertically. Some cystidia are entirely embedded, others project up to 70 μ; they are 12—16 μ diameter, cylindric, conical above, obtuse, encrusted, hyaline, becoming brownish.

Bresadola, in Ann. Myc., XIV, p. 242, states that this species does not differ much from *Peniophora velutina* (DC.); he describes the cystidia as clavate, 140—150 x 9—12 μ.

Peniophora gigantea (Fr.) Massee. Recorded for Ceylon in Fungi of Ceylon, No. 643, as *Corticium giganteum* Fr. The Ceylon specimens

spread widely over dead wood or earth, and are horny when dry. The thickness of the fructification is about 0·5 mm. The greater part of the thickness, 0·4 mm., consists of a red-brown, horny layer, pale yellow in section, interrupted here and there by pockets containing a loose network of hyphae, 2—3 μ diameter. Above this horny layer is a narrow hyaline zone, about 50 μ thick, of loosely interwoven hyphae; and above that another yellow, horny layer, 30—50 μ thick. The hymenium forms a thin film on the surface. Cystidia occur on the older parts, and are conical, obtuse, hyaline, strongly encrusted, 30—55 x 14—16 μ. This does not appear to agree completely with recent descriptions of the European species.

A recent young specimen was, when fresh, red-brown in the centre, becoming orange outwards, with a white margin This does not show the doub'e structure in the upper part.

Peniophora sparsa (B. & Br.) Cooke. This was described by Berkeley and Broome as *Corticium sparsum*. Fungi of Ceylon, No. 650. Cooke, in Grevillea, VIII, p. 21, transferred it to *Peniophora*. It has been re-described by von Höhnel and Litschauer in Beiträge zur Kenntnis der Corticieen III, from specimens and data supplied from Ceylon.

Peniophora stratosa Petch, n. sp. Effused, cream-coloured, even, compact, up to 0·35 mm. thick ; internally white, stratose, hyaline in section with yellow zones ; basal layer thin, compact, composed of hyphae parallel to the substratum, intermediate tissue rather loose, composed of irregular agglutinated hyphae with numerous interspaces ; basidia, clavate, 6-8 μ diameter ; cystidia at all depths, hyaline, conical, encrusted, almost solid, 80-110 x 15-30 μ, projecting up to 70 μ ; spores broadly oval or oblong-oval, hyaline, 8-12 x 6 μ. On a dead branch, Peradeniya, May 1915 ; No. 4677 in Herb. Peradeniya.

Peniophora fisso-reticulata Petch, n. sp. Widely effused, white, cream-coloured in the thicker parts, margin abrupt, or merging into extensive powdery patches, cracking into numerous, rather widely separated, irregular lines and small patches ; thickness about 0·1 mm. ; no definite basal layer ; context of hyaline, interwoven hyphae running more or less vertically ; basidia clavate, 3-4 μ diameter ; cystidia irregularly conical or cylindric, obtuse, encrusted, hollow towards the apex, 16-24 x 8-9, μ projecting up to 20 μ ; spores oval, hyaline, 4-6 x 2·5-3 μ. On dead branches, Peradeniya, May 1915 ; No. 4689 in Herb. Peradeniya.

Peniophora excurrens Petch, n. sp. Mycelium ochraceous yellow, spreading widely over mosses, leaves, chips of wood, etc., in coarse strands which are subsequently united by thin byssoid sheets on which the hymenium is developed. Hymenium pale purplish grey or reddish grey, pruinose ; margin yellow, byssoid ; lower surface byssoid, yellow ;

context spongy, yellow or pale brown in section. Thickness up to 0·6 mm.; basal layer thin; context of strongly encrusted, yellow hyphae, 3-4 μ diameter, loosely interwoven ; hymenial layer red-brown, sometimes stratose. Cystidia up to 64 μ long, 8-10 μ diameter, conical or cylindric, strongly encrusted, obtuse, projecting up to 50 μ ; basidia cylindric, 4 μ diameter, accompanied by strongly encrusted, cylindric, yellow hyphae projecting up to 30 μ ; spores oval, minutely warted, pale yellow, 4 x 2 μ. Hakgala, fairly common ; type, No. 4575, January 1914.

In one collection of this species, the fructification is not stratose, and the cystidia are hyaline and project strongly. In other collections, the stroma is stratose, and shows three successive hymenia, the upper part consisting of alternate yellow and red-brown layers. The cystidia in these latter specimens do not exceed 50 μ, do not project more than 16 μ, and are yellow. In parts of these specimens, the hymenium is waxy, red-brown, and cracks on drying, and the fungus, when growing on wood, may develop a compact, red-brown, basal layer. The parts with a smooth hymenium resemble *Corticium simulans* in appearance, and the latter has similar mycelium, but it lacks cystidia and its hyphae are different.

Peniophora decidua Petch, n. sp. Dark slate coloured, with a narrow, blackish brown margin, pruinose, forming oval or circular patches, about 1 cm. x 5 mm., or confluent in irregular patches, about 2 x 1 cm. ; thickness 0·05-0·1 mm., basal layer none, fructification composed of irregular stout hyphae, more or less vertical, 3 μ diameter, hyaline above ; cystidia conical, hyaline, encrusted, up to 36 μ high, projecting up to 20 μ, with similar, vertically-oval bodies entirely embedded in the stroma, both ultimately falling out and leaving very minute holes ; basidia expanding upwards, 8 μ diameter, sterigmata short, 3 μ long. On dead *Hevea*, Pallegodde, January 1912 ; No. 3350.

THELEPHORA

The majority of the species assigned to *Thelephora* in the Fungi of Ceylon are *Septobasidium*.

Thelephora atropurpurascens B. & Br., Fungi of Ceylon, No. 580, was transferred to *Punctularia*, as *Punctularia atropurpurascens* (B. & Br.) Petch, in Ann. Perad., VI., p. 160.

Thelephora submembranacea B. & Br., Fungi of Ceylon, No. 584, was described as " Late effusa, secernibilis, hymenio fulvo-umbrinoe sporis pulverulento (No. 987). Spores tawny, oblique, ·00028 long." Cooke, in Grevillea, VIII., p. 89, transferred it to *Coniophora*, and Massee, Mon. Theleph., stated that the spores were elliptico-fusoid, 10-12 x 5 μ.

The specimen, Thwaites 987, in Herb. Peradeniya has been detached from the host and gummed on paper, but it is cracked into rather small pieces. It is widely effused, purple-brown to tawny brown, and not now markedly pulverulent. It is 0·3 mm. thick, yellow-brown internally. The context consists of irregular hyphae, 1-2 μ diameter, rather loosely interwoven and containing masses of calcium oxalate in the lower part, but dense above. In the upper part of the stroma, irregular hyphae about 4 μ diameter run more or less vertically, and these divide into irregularly flexuose branches, 2-4 μ diameter, which form the hymenium. The spores are yellow-brown, narrow oval, inequilateral, or somewhat attenuated to the distal end, with a prominent excentric apiculus, 5-9 x 3-4 μ, and resemble the spores of an agaric. They are situated throughout the upper third of the fungus, with a definite red-brown zone of spores at a depth of about 80 μ from the surface. I have not been able to determine basidia.

Thelephora cristatella B. & Br., Fungi of Ceylon, No. 572. This was described as " Pusilla, nivea, cuneiformis, deorsum tomentosa, sursum acute cristato-divisa. Whole plant half an inch, wedge-shaped, tomentose below, above divided in a crest-like manner into a few very acute radiating divisions ".

The specimens in Herb. Peradeniya (Thwaites 1021) are 8 mm. high, flattened, fan-shaped or wedge-shaped, 0·5-1 mm. diameter below, expanding to a breadth of 5 mm. above and dividing at the upper edge, into numerous long, conical teeth. Apparently they were erect in growth. The dorsal (?) surface is strongly longitudinally ridged with coarse fascicles of agglutinated hyphae, which sometimes terminate in free, slightly recurved points, similar to the marginal teeth. The other side is also ridged, but not so strongly. The fungus is white, or cream coloured, and tomentose, the marginal teeth appearing yellowish and horny. In cross section at about half the height of the fungus, the thickness is about 0·7 mm. The section shows an external, white, somewhat loose tissue, composed of hyaline hyphae, 2-3 μ diameter, with a narrow, irregular, translucent, middle layer, interrupted here and there, which appears to be formed by the coalescence of adjacent bundles of vertical fibres. The white tissue also contains, in cross section, minute, scattered, translucent areas, which are the sections of the cores of the ridges seen on the surface. Thus the middle layer of the fungus is horny, and it is this layer which divides up into the marginal fringe. Basidia have not been observed. The specimens are apparently immature. Though originally collected at Peradeniya, it has not been recognised again.

Thelephora reticulata Petch, n. sp. Total height up to 2 cm., consisting of a number of pilei arising from a common base, and forming a rosette up to 1·5 cm. diameter; individual pilei narrowly stalked, about 1 mm. diameter below, wedge-shaped, or divided into wedge-shaped lobes almost down to the base; lobes about 2 mm. broad, shortly divided at the apex into obtuse, bicrested segments or into conical teeth; purple-black when fresh, and appearing glabrous and cartilaginous, with purple-brown subtranslucent tips; when dry blackish brown, pale brown or ashy at the tips, tomentose at the base, minutely reticulated above and pruinose or minutely tomentose, coriaceous; thickness of individual lobes 0·5 mm., internally rather loose; spores pale purple-brown, irregularly oval, 8-12 x 4-7 μ, or globose, 6-8 μ diameter, nodular. On the ground, Peradeniya, August 1921; No. 6522.

Cesati recorded *Thelephora multipartita* Fr. var. *fuscella* from Sarawak and Ceylon. Lloyd, who has examined Cesati's specimen, states that it is not *Thelephora multipartita*, and has named it *Thelephora fuscella*. His photograph of the type shows a larger species, and less divided, than that described above. Whether the specimen photographed is from Ceylon or Sarawak, or whether there are two examples in the type, from Sarawak and Ceylon respectively, is not evident.

ODONTIA

Peniophora ambigua (B. & Br.) Massee. This species was founded by Massee on *Hydnum ambiguum* B. & Br. (Thwaites 974). Berkeley and Broome described it as having "aculeis minutis dense approximatis rimosō-congestis tomentosis," and stated that the prickles were so small that they were scarcely visible to the naked eye. Massee found cylindrico-fusoid cystidia, 50-60 x 12-14 μ, and stated that the plant presented "the appearance of a resupinate *Hydnum*, the fascicles of cystidia closely resembling the spines of the last mentioned genus."

The fungus in Thwaites 974 is resupinate, pinkish ochraceous, with a narrow white margin. From a very thin, sometimes arachnoid, basal layer, there arise numerous processes, closely crowded together. These processes are about 0·3 mm. high, and 0·1-0·2 mm. thick; they may be cylindric, or conoid, or thin plates which are curved laterally and sometimes form a hollow cylinder. Here and there they are fused into small tufts, or pulvinate patches, irregularly crested above. The processes or plates are composed of vertical hyphae, the tips of the shorter curving outwards to form paraphyses. Cystidia occur on the basal layer and over the processes; they are cylindric, obtuse, up to 50 x 6 μ, hyaline, and verrucose. The shorter clavate paraphyses are also verrucose.

This species is neither a *Hydnum* nor a *Peniophora*. The processes are not fascicles of cystidia. It would appear to be nearest to *Odontia*, and, *Odontia ambigua* being preoccupied, it may stand as *Odontia conferta* nom. nov.

Odontia membranacea Petch, n. sp. Mycelium white, spreading in radiating dendritic strands over decaying wood, mosses, etc., ultimately fusing into continuous sheets ; hymenium at first pinkish, then pale brown with a pink tinge, brownish white when dry, pruinose, margin byssoid ; stroma separable, up to 0·2 mm. thick, composed of loosely interwoven, slender, hyaline hyphae ; processes scattered, conical or cylindric, sometimes forked, up to 0·2 mm. high,50–100 μ diameter, of rather loose, more or less erect, hyaline hyphae, the free ends of which are encrusted with large crystals of calcium oxalate. Hakgala, October 1914 ; No. 4749.

TOMENTELLA

Tomentella porphyrea Petch, n. sp. Effused, at first byssoid, becoming spongy, tomentose, nodular, purple-grey to purple-brown with a white, byssoid margin. Thickness up to 0·2 mm., context of loosely interwoven, thin-walled hyphae, pale brown to hyaline, up to 8 μ diameter, with prominent clamp connections ; basidia clavate, 10 μ diameter, four-spored, sterigmata conical, up to 10 μ long ; spores slightly irregularly oval or globose, purple-grey in mass, pale purple-brown by transmitted light, coarsely spinulose, 6–11 x 5–8 μ, or 7–8 μ diameter. On fragments of wood and bark, Hakgala, May 1912 ; December 1917. Type, No. 5521 in Herb. Peradeniya.

The thinner byssoid stromata retain their purple-brown colour in the herbarium ; the thicker specimens become yellowish grey.

SEPTOBASIDIUM

It is hoped to publish a separate account of the Ceylon species of *Septobasidium*. Meanwhile, the following synonymy may be recorded.

Thelephora pedicellata Schw., Fungi of Ceylon, No. 574 = *Septobasidium pedicellatum* (Schw.) Pat. ? Burt states that *Septobasidium pedicellatum* Pat. from Cuba is not the same as *Thelephora pedicellata* Schw. The Ceylon specimens under this name, Thwaites 342, are a mixture.

Thelephora suffulta B. & Br., Fungi of Ceylon, No. 575 = *Septobasidium suffultum* (B. & Br.) Pat., Essai Taxonomique (1900), p. 10 = *Septobasidium suffultum* (B. & Br.) Bres., Ann. Myc., XIV. (1916), p. 241.

Thelephora dictyodes B. & Br., Fungi of Ceylon, No. 576 = *Septobasidium dictyodes* (B. & Br.) Pat., Bull. Soc. Myc. France, XXIV p. 2 (1908) = *Septobasidium dictyodes* (B. & Br.) Bres., Ann. Myc. XIV (1916), p. 241.

Thelephora capnodes B. & Br., Fungi of Ceylon, No. 577 = *Septobasidium capnodes* (B. & Br.) Bres., Ann. Myc., XIV (1916), p.241.

Thelephora lichenicola B. & Br., Fungi of Ceylon, No. 578 = *Septobasidium lichenicolum* (B. & Br.) Petch, Ann. Bot., XXV (1911), p. 842.

Thelephora Thwaitesii B. & Br., Fungi of Ceylon, No. 583 = *Septobasidium Thwaitesii* (B. & Br.) Pat., Bull. Soc. Myc. France, XXIV (1908), p. 2.

Thelephora arachnoidea B. & Br., Fungi of Ceylon, No. 581. Burt, Ann. Missouri Bot. Gard., III, p. 214, states that this is *Hypochnus umbrinus* (Fr.) Burt = *Thelephora umbrina* Fr. Bresadola, in Ann. Myc., XIV (1916), p. 241, refers it to *Septobasidium*, as *Septobasidium arachnoideum* (B. & Br.) Bres. The latter appears to be correct.

Thelephora subcarbonacea B. & Br., Fungi of Ceylon, No. 582 = immature *Septobasidium arachnoideum* (B. & Br.) Bres.

Thelephora accumbens B. & Br., Fungi of Ceylon, No. 585 = *Septobasidium accumbens* (B. & Br.) Bres., Ann. Myc., XIV (1916), p. 241.

The specimen, Thwaites 544, mentioned by Berkeley and Broome under *Thelephora accumbens*, is referred by Bresadola (*loc. cit.*) to *Septobasidium Merrillii* Bres.

Hymenochaete ramealis Berk., Fungi of Ceylon, No. 611 = *Stereum rameale* Mass., Mon. Theleph., Pt. II, p.187 = *Septobasidium aligerum* Petch, *nom. nov.*, *non* = *Septobasidium alatum* Lloyd.

Corticium reticulatum B. & Br., Fungi of Ceylon, No. 628 = *Corticium Marescalchianum* Manc. and Sacc., Sylloge, VI, p. 633 = *Corticium flavovirens* Massee, Mon. Theleph., p. 154 = *Septobasidium reticulatum* (B. & Br.) Pat., Bull. Soc. Myc. France, XXIV (1908), p. 2.

Corticium suffultum B. & Br., Fungi of Ceylon, No. 651 = *Septobasidium leucostemon* Pat., Bull. Soc. Myc. France, XXXVI (1920), p. 175.

Corticium alopecinum B. & Br., Fungi of Ceylon, No. 631 = *Septobasidium alopecinum* (B. & Br.) Petch, *comb. nov.*

Corticium murinum B. & Br., Fungi of Ceylon, No. 635 = *Septobasidium murinum* (B. & Br.) Petch, *comb. nov.*

Lachnocladium rameale B. & Br. = *Septobasidium rameale* (B. & Br.) Petch, Ann. Bot., XXV (1911), p. 842.

Caesalpinia Bonduc L. and Caesalpinia bonducella Flem.

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

In 1857, W. Ferguson examined the specimens of Hermann's Musaeum Zeylanicum, and made notes on them which are now in the Peradeniyá Library. With regard to Flora Zeylanica, No. 156, he wrote, "Ic. good, showing swelled three-seeded fruit. It is the round-seeded one that strikes fire." The specimen is *Caesalpinia bonducella* Fleming.

Ferguson had travelled widely through Ceylon, and had a remarkably good field knowledge of its Flora. It is to be observed that in this instance he identified the plant in question correctly, and, judging from his note, that he had been in the habit of identifying it by the shape of its seeds. Unfortunately, there is no specimen of *Caesalpinia Bonduc* among Hermann's Musaeum Zeylanicum specimens, and consequently it is not possible to ascertain Ferguson's idea of the shape of the seeds of that species. But evidently, for him, the species with globose seeds was *Caesalpinia bonducella*.

It appeared of interest to examine the descriptions of *Caesalpinia bonducella* and *Caesalpinia Bonduc* to see what characters had been relied upon by different authors for the separation of these two species, and whether this character, the shape of the seed, had been taken into consideration. In discussing these descriptions below, I have retained the names *Caesalpinia Bonduc* and *Caesalpinia bonducella* under which the two Asiatic plants have been recognised during the last hundred years. The confusion of the Linnean specimens was noted by Ferguson, and the facts were published independently by Trimen. Merrill considered the synonymy of the two species, but did not push his findings to their logical conclusion. It would seem that this is eminently a case to which the principle of *nomina conservanda* should be applied.

Baker, in Flora British India, stated that *Caesalpinia Bonduc* has ascending bracts, and leaves without stipules; and that it differs from *C. bonducella* in the absence of the reduced stipular pinnae, and in its

smaller, not squarrose bracts; he did not describe the seeds. According to the same authority, *C. bonducella* has stipules, oblong, obtuse, mucronate leaflets, squarrose bracts, and *oblong, lead-coloured seeds*.

Under *C. Bonduc*, Baker cited *C. Bonduc*, Roxb. Hort. Beng. 32, Fl. Ind. II. 362, DC. Prod. II. 480 ; *G. glabra* Miller Dict. No. 3. Under *C. bonducella*, he cited *C. bonducella*, Roxb. Fl. Ind. II. 357, Fleming in Asiatic Res. XI 159 ; *G. Bonduc* W. & A. Prod. 280, Dalz. and Gibs. Bombay Flora 79 (in part). Later botanists disagree with these citations. Gamble, Flora Presidency Madras, regards both W. & A. Prod. 280 and DC. Prod. II. 480 as including both species ; and Cooke, Flora Presidency Bombay, regards W. & A. Prod. 280 as being only in part *C. bonducella*, while he cites Dalz. & Gibs. Bombay Flora 79 as that species, without the qualifying " in part."

Roxburgh, in Flora Indica, stated that *Caesalpinia Bonduc* has oval, mucronate leaflets, and *C. bonducella*, ovate-oblong leaflets, reflexed bracts, and pinnatifid stipules. He did not describe the seeds. Under *C. bonducella*, Roxburgh remarked that plants reared from seed from the West Indies proved to be exactly the same, and that the seed is a powerful tonic ; while under *C. Bonduc* he stated that this species had been introduced into the Botanic Garden, Calcutta, from Sumatra, but had not flowered, though it had grown luxuriantly.

Under *C. bonducella*, Roxburgh cited Rumph, Amb. 5, t. 49, fig. 1, and Rheed. Mal. ,2, t. 22. Rheede's figure shows elliptic seeds, somewhat intermediate in character, but nearer *C. Bonduc*, stipules, scattered prickles, recurved bracts, and leaflets varying from obtuse to acute; he described the seeds as " oblongo-rotundo, cortice duro albocinereo venulisque nigris undulantibus striato." Rumph. Amb. 5, t. 49 fig. 1, shows acute leaflets, paired prickles on the rachis, a lax inflorescence with scarcely reflexed bracts, and foliaceous stipules; he did not figure the seeds, but described them as " ex rotundo parum oblonga et ad latera compressa, cinerei coloris, quaedam vero caerulescunt et alia nigrescunt."

Rumphius Herb. Amb. 5, t. 48, which is taken as *Caesalpinia Bonduc*, shows oval-lanceolate leaflets, scattered prickles, no stipules, a lax inflorescence, and subglobose seeds. He described the seeds of this species as round, like marbles, and " Coloris pallide cinerei, glabra et splendentia circulis quibusdam subtilibus notata, et ad unam partem parum protuberantia, ubi et gilva macula notata sunt, qua siliquae fuere nexa ; horum quaedam perfecte sphaerica sunt, excepto illo prominente angulo, quaedam magis oblonga instar ovorum lacertae, quaedam cinerea penitus sunt, alia pallidiora, et albicantia." According to Ceylon experience, this description would cover the seeds of both species.

Miller, Dictionary, styled *Caesalpinia Bonduc*, the Yellow Bonduc, and stated that it had seeds about the size of marbles and of a yellowish colour. *C. bonducella* he named the Grey Bonduc, and described the seeds as ash-coloured, grey, commonly used as marbles by boys in the sugar colonies ; and again as ovate-globular, very smooth and shining, seeming as if they had very fine parallel annular clefts, but quite entire, of a livid lead colour, with a brown mark at the navel.

Miller repeated Sloane's record that the seeds of *Caesalpinia bonducella* are cast ashore on the North West coasts of Ireland and Scotland and are there called Molucca Beans. He also quoted Sloane's statement that there is no difference between *Caesalpinia bonducella* and *Caesalpinia Bonduc* except in the colour of the nut, which in the latter is yellowish, finely variegated with annular or interrupted saffron-coloured zones ; presumably this refers to Jamaican specimens.

Miller's second description of the seeds of *C. bonducella* is identical with that of Gaertner, De Fructibus, II (1791), p. 315, and the description of the seed of *C. Bonduc*, *ex* Sloane, is also the same as Gaertner's. The latter's specimens of seeds of *C. bonducella* were obtained from Miller. Gaertner figures the seeds of the two species the same shape, ovato-globose, but not round enough to be used as marbles.

Lunan, Hortus Jamaicensis, 1814, stated that *C. Bonduc* has yellow seeds like marbles, and ovate leaflets with single prickles on the mid-rib, while *C. bonducella* has grey seeds like marbles, and two opposite prickles below each pair of leaflets.

Returning to Eastern writers, we find that Gamble, in Flora Presidency Madras, describes *C. Bonduc* (*C. Jayabo*) as having elliptic-oblong acute leaves, and no stipules, and *C. bonducella* (*C. crista*) as having foliaceous stipules, and elliptic-oblong, obtuse, mucronate leaflets. He states that the seeds of both are *globose* and grey.

Cooke, Flora Presidency Bombay, does not record *C. Bonduc*, but describes *C. bonducella* as having elliptic-oblong, obtuse, strongly mucronate leaflets, stipules a pair of reduced pinnae each furnished with a long mucronate point, flowers in dense racemes, squarrose bracts, and *oblong, lead-coloured seeds.*

Haines, Botany of Bihar and Orissa, records *C. bonducella* (*C. crista*) only, and states that it has leaflets with obtuse, mucronate tips, and *large round seeds.* Both Cooke and Haines style *C. bonducella*, the Fever Nut.

In the Dictionary of the Economic Products of India, *Caesalpinia bonducella* is again given as the Fever Nut and as the Sinhalese Kumburu. It is also stated that "At the late Colonial and Indian Exhibition, a pale orange-coloured nut was shown by the West Indian Colonies as

obtained from a special cultivated form of this plant. This is not known in India, the nuts being all of a slaty olive-green." A Bangalore correspondent is cited for the information that the seeds are used as marbles. This work does not mention *C. Bonduc.*

Grisebach, Flora of the British West Indian Islands, included *Guilandina Bonduc,* stipules abortive, seeds yellow ; *Guil. bonducella,* stipules cut into large segments, seeds lead-coloured ; and *Guil. glabra* Mill., " seeds grey " (Duchass.).

Fawcett and Rendle, Flora of Jamaica, include *Caesalpinia Bonduc,* stipules wanting, seeds yellow, *subglobose* (with all Grisebach's names as synonyms); and *Caesalpinia bonducella,* stipules of two or three leaf-like segments, seeds pale greenish grey, *subglobose.*

It is evident from the descriptions that the principal difference between the two species is that *C. bonducella* has leafy stipules, while *C. Bonduc* has none.

As regards the other characters, *C. bonducella* has a dense inflorescence, with squarrose bracts, and *C. Bonduc* a more lax inflorescence with straighter bracts.

The leaflets of *C. bonducella* are ovato-oblong (Roxburgh), oblong, obtuse (Baker), elliptic-oblong, obtuse (Gamble, Cooke), obtuse (Haines); but variable in Rheede's figure, and acute in that of Rumphius. The leaflets of *C. Bonduc* are oval (Roxburgh), ovate (Lunan), elliptic-oblong, acute (Gamble), and oval-lanceolate in Rumphius's figure.

Lunan stated that *C. bonducella* has two opposite prickles below each pair of leaflets, while *C. Bonduc* has single prickles on the midrib (? the secondary rachis). Rumphius's figure shows prickles in irregular pairs on the main rachis of the former species, but on Rheede's figure they are scattered.

As regards the seeds, the descriptions differ rather widely. All West Indian writers state that the seeds of both species are the same shape but differ in colour, those of *C. Bonduc* being yellow, and those of *C. bonducella* grey. In India, Gamble states that the seeds of both are globose and grey ; Baker and Cooke state that the seeds of *C. bonducella* are oblong and lead-coloured, but Haines says that they are round. Rumphius stated that the seeds of *C. Bonduc* were variable, some round, some oblong, and those of *C. bonducella,* " ex rotundo parum oblonga," while Rheede described those of the latter as " oblongo-rotundo."

In Ceylon, the seeds of *C. Bonduc* are lead-coloured, shining, oblong-oval or narrow oval, not compressed, like the eggs of a lizard in shape. The hilum is at one end, is brown, and sometimes bears a minute projecting point, the remains of the funicle. The seeds are marked with fine, more or less parallel lines, concentric with the hilum ; under a high

magnification, some of these lines are seen to be raised ridges. The average weight per seed of twenty-eight seeds from Henaratgoda was 1·71 grams, the heaviest weighing 2·05 grams and the lightest 1·23 grams. The average weight per seed of fifty seeds from Kalutara was 1·75 grams, the heaviest weighing 2·25 grams and the lightest 1·18 grams.

The seeds of *C. bonducella* in Ceylon are grey and comparatively dull. Some may have an olive or yellowish olive tinge, but that indicates that they have been taken from unopened pods. In shape they are irregularly globose, slightly, or sometimes strongly, laterally compressed, and often with one or more flattened facets. The hilum is brown and does not project. A few seeds are ellipsoidal, but in these the hilum is situated on the long side of the ellipse, not terminally as in *C. Bonduc*. They are marked with fine, more or less parallel, dark lines, concentric with the hilum. These lines, on fresh specimens, appear as ridges when magnified. As the lines are concentric with the hilum, they run lengthwise on the ellipsoidal seeds. The average weight per seed of one hundred Ceylon seeds of *C. bonducella* was 2.16 grams.

Seeds of *C. bonducella* from Coimbatore and Madras are the same as the Ceylon seeds in colour and shape. The average weight per seed of one hundred seeds from Madras was 2·57 grams, the heaviest weighing 3·42 grams and the lightest 1·61 grams. The average weight per seed of forty seeds from Coimbatore was 2·44 grams.

As far as Ceylon is concerned it would appear that Ferguson was correct, and that *C. bonducella* can be distinguished from *C. Bonduc* by the shape of its seeds. Both in Ceylon and India, the seeds of *C. bonducella* are irregularly globose, and might be used as marbles with some sacrifice of accuracy. But the seeds of *C. Bonduc* answer rather to Gilbert's elliptical billiard balls.

The seeds sold in the Ceylon bazaars as Kumburu are invariably subglobose, and plants raised from bazaar seed have proved to be *C. bonducella*. Apparently, only the seed of *C. bonducella* is used medicinally in the East.

The leaflets of *C. bonducella* are typically elliptic-oblong, obtuse, those of *C. Bonduc* ovate, acute, sometimes acuminate. But though the general appearance of a plant of *C. bonducella* gives the impression that all the leaflets are elliptic-oblong, they are really variable, and some approach the leaflets of *C. Bonduc* in shape, as shown in Rheede's figure. Thus, when only part of a leaf is available the specimen may be misleading. In both species the leaves are strongly mucronate.

Caesalpinia bonducella, in the Ceylon specimens, has a pair of prickles on the secondary rachis below each pair of leaflets, as noted by Lunan. *C. Bonduc*, in Ceylon specimens, may have paired prickles or a single prickle in that position, but this feature is variable, and most of the pairs of leaflets have no accompanying prickles.

The leafy stipules of *C. bonducella* appear at first sight to constitute a sufficient distinguishing character. This, however, has evidently proved inadequate. When plants are grown from seed, no stipules are produced until after about a dozen leaves have appeared. That would not affect diagnosis in the majority of cases, as seedlings would not be collected. But as the plant matures and the stems become woody, the stipules fall off, and no clearly marked scar is left on the stem. This, in conjunction with the peculiar constitution of the flowers of *C. bonducella*, makes identification of fruiting specimens by means of the stipules frequently impossible.

As is well known. the flowers of *C. bonducella* are frequently male only, the pistil being rudimentary. When plants grown from seed first came into flower, all the flowers contained only rudimentary pistils, and this state continued for several months After about six months, the inflorescences produced towards the ends of the rapidly-growing green shoots were still imperfect, but those developed on other shoots, possibly of slower growth, were perfect, and began to set fruits. In some of the latter instances, the stipules had been shed as soon as the fruits began to form. Thus, specimens collected from the periphery of the plant would bear inflorescences with imperfect flowers and leaves with stipules, while the fruiting specimens from deeper in the tangle might not bear stipules. This is the more likely to occur, since the fruits take about five months to ripen.

It is evident that if fruiting specimens, or specimens from old plants, are judged simply by the presence or absence of stipules, the identification may be incorrect. Of four sheets included under *C. Bonduc* in the Peradeniya herbarium, three are *C. bonducella*. None of these three bears any stipules. One specimen bears fruit only. The other two sheets are from one locality on the same date, and probably from the same plant. One of the latter is in fruit and shows the typical leaflets, prickles, and seeds of *C. bonducella* ; the other has the same leaflets, and a crowded inflorescence with squarrose bracts.

The flowers on one inflorescence of *C. bonducella* appear to be all of the same character, i.e., they are either all perfect or all imperfect. On the inflorescences which bear imperfect flowers, the flowers are more crowded and the bracts more conspicuous than on those which bear perfect flowers. The perfect flowers are larger, of a deeper yellow, and

have the red spots and streaks on the dorsal petal more pronounced, than the imperfect flowers. On the specimens under cultivation, it was possible to tell which inflorescences bore perfect flowers, when they were in bud, as the buds were larger, and darker owing to the greater development of the brown tomentum. On the imperfect buds, the tomentum was only slightly developed, and sometimes barely evident.

From the foregoing details, it would appear that the shape of the seeds is, in Ceylon, a valid distinguishing character between *C. Bonduc* and *C. bonducella*, but that the shape of the leaflets and the presence or absence of stipules may be unreliable. Further examination of living examples of these two species in other countries would seem desirable.

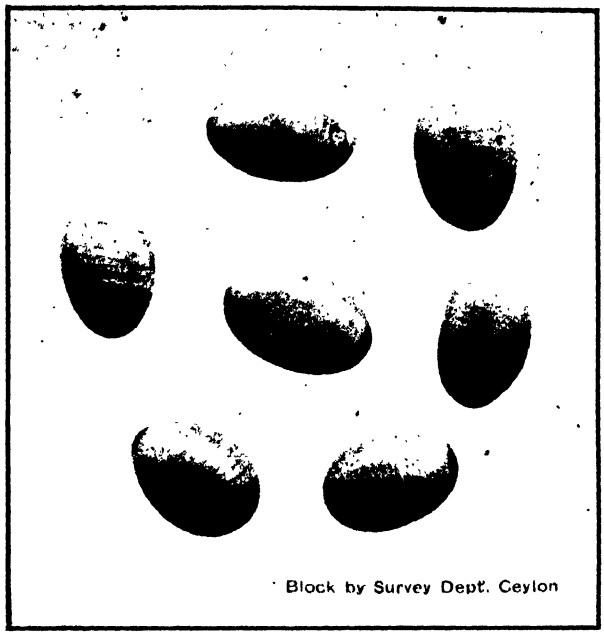


Fig. 1.—Seeds of *Caesalpinia Bonduc*, nat. size

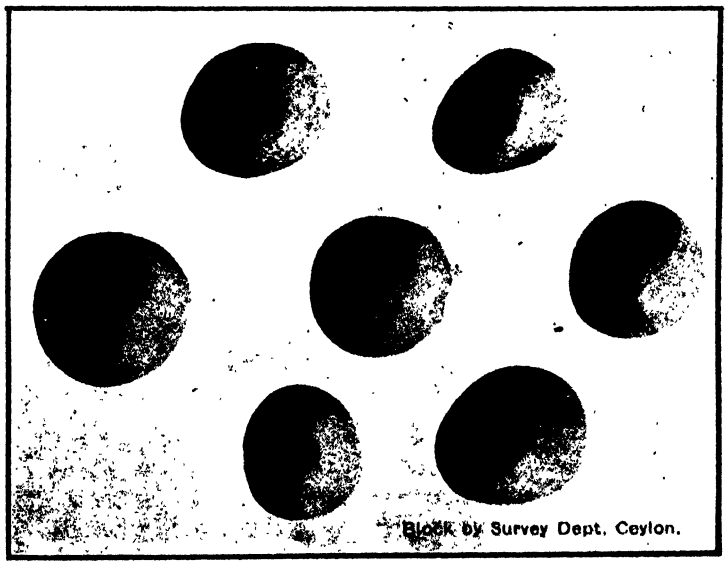


Fig. 2.—Seeds of *Caesalpinia bonducella*, nat. size

The Genus Chukrasia

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Trimen (3) follows Hiern (1) in calling this genus Chickrassia, after its Bengali name Chickrassi, though it was named Chukrasia by Jussieu. Under *C. tabularis* A. Juss., Trimen has the following note.—"Our plant is the variety with the leaves silky-tomentose, which is *C. velutina* Roem., and is maintained as distinct from *C. tabularis* by Cas. D.C. in his monograph. I have only seen 4-merous flowers, but in Fl. B. Ind. the anthers are given as 10 and the ovary and capsule 3-celled, and in Wight and Beddome's figure the ovary is 5-celled." Specimens collected at Hakkinda recently differ from Trimen's description of the Ceylon plant. The chief points of difference between the Hakkinda specimens and the specimens (of which there are only two sheets in the Peradeniya Herbarium) from which Trimen made his description of the Ceylon plant are tabulated below. The former can at sight be distinguished, in that its leaves are glabrous while those of the latter are covered with a silky tomentum.

	Hakkinda Specimens.	*Trimen's Specimens.*
1.	Leaflets uniformly acute towards the apex which is distinctly cuspidate.	Leaflets abruptly and shortly acuminate.
2.	Leaflets glabrous.	Leaflets silky-tomentose.
3.	Flowers long-pedicelled (average length 5 mm.).	Flowers short-pedicelled (average length 2 mm.).
4.	Outer surface of sepals villose.	Outer surface of sepals tomentose.
5.	Petals membranous.	Petals fleshy.
6.	Stamen tube distinctly toothed.	Stamen tube neither toothed nor veined.
7.	Anthers 10, elliptic.	Anthers 8, ovate.

C. de Candolle (2) described both *C. tabularis* and *C. velutina* as having ten anthers each and placed the Ceylon plant under *C. velutina*. (Trimen is the only author who has mentioned this variation in the number

of anthers in the Ceylon specimens.) Trimen's specimens were from within a very small area of the Central Province, viz. from Deltota, Hanguranketa, and Kandy. Hakkinda is within this area and does not differ appreciably from any of the other three localities, either in climatic conditions or elevation. These differences in the characters of the Hakkinda plant are therefore not local and it is entitled to be regarded as a distinct species. The Hakkinda plant should be called *Chukrasia tabularis* Juss., while Trimen's plant (3) should be *C. velutina* Roem.

The descriptions given below are of the two Ceylon species of Chukrasia and do not include descriptions of the Indian plants.

Chukrasia A. Juss.

Large trees. Leaves imparipinnate, rachis 8–10 in. long, terete ; leaflets 10–20, alternate, entire, stalked, very unequal at the base. Inflorescence a terminal, or axillary, pyramidal panicle of pedicellate, hermaphrodite flowers. Calyx shallowly 5-lobed. Petals 5, free, contorted, linear-oblong, spreading. Stamens connate into a tube, which is slightly shorter than the petals, toothed or not. Ovary superior, 3–5-celled ; ovules numerous, superposed, in two rows. Stigma discoid. Fruit a woody, septifragal capsule. Seeds exalbuminous, rough, compressed, with a large slender wing.

1. *C. tabularis* A. Juss. Mem. Mel. p. 141.

Tree glabrous throughout. Leaves with 5–8 pairs of distinctly cuspidate leaflets. Panicles equal to or greater than half the length of the rachis. Flowers long-pedicelled. Calyx villous externally. Petals membranaceous. Stamen-tube distinctly toothed : anthers 10, elliptic.

Hakkinda. Fl. May.

2. *C. velutina* Roem. Syn. fasc. 1. p. 135 ; D.C., Mon. Phan., 1. (1877), p. 727.

Tree tomentose throughout. Leaves of 8–10 pairs of shortly acuminate silky-tomentose leaflets. Panicles tomentose, shorter than half the length of the rachis of the leaf. Flowers shortly pedicelled. Calyx tomentose. Petals fleshy. Stamen-tube not toothed. Anthers 8, ovate.

Deltota, Hanguranketa, Kandy. Fl. May.

REFERENCES

(1) Hiern, W. P. in Sir J. D. Hooker's Flora of British India, 1 (1875), 567.

(2) De Candolle, C. Monographiae Phanerogamarum, 1 (1877), p.726, 7.

(3) Trimen, H. Flora of Ceylon, 1 (1893), pp. 251, 2.

Clathrus crispatus Thwaites

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

Berkeley, in Hooker's London Journal of Botany, VI., pp. 479–514 (1847), recorded *Clathrus cancellatus* for Ceylon from specimens collected by Gardner, and the same species was recorded by Berkeley and Broome in Fungi of Ceylon, No. 700, from Thwaites' collection. Thwaites, however, had considered the Ceylon species distinct from the European *Clathrus cancellatus*, and had marked his specimens and the paintings which accompanied them *Clathrus crispatus*. The latter specimens, which are represented in the Peradeniya herbarium, were collected on Hantane in 1859, and there is also a specimen collected at Hakgala in 1881.

Fischer, in Neue Untersuch. Phalloideen, 1893, adopted Thwaites' unpublished name for this species. He had examined fragments of the Ceylon specimens from Hantane, which were in the Kew herbarium together with pieces from Myrong, Khasia, and Merida, Yucatan, doubtfully referred to *C. crispatus*. He stated that all the foregoing examples were in a fragmentary condition, but as far as could be determined they represented a distinct species intermediate between *Clathrus cancellatus* and *Clathrus crispus*. In agreement with *Clathrus crispus* the meshes of the net were rounded and decreased in size from the base upwards, while the branches appeared to be flat and thin and not so massive as those of *Clathrus cancellatus*. He could not distinguish on the meshes of the net the obliquely ridged margin which is characteristic of *Clathrus crispus*, and considered that the spore mass must be more limited to the inner side of the net than in the latter species. But better material was necessary, to decide whether it was really a good species. In Untersuch. Phalloideen, 1900, Fischer listed *Clathrus crispatus* among the insufficiently known species.

There are two paintings of this species in Herb. Peradeniya. One, labelled July 29, 1859, shows two unexpanded specimens, spherical,

brownish or yellowish grey, 7 cm. in diameter, marked above with hexagonal areas about 1·5 cm. across, and below with elongated polygonal areas which extend to the base. The mycelium consists of numerous, thick, white cords. The other painting is labelled "*Clathrus crispatus*, Hantane, elev. 4000 feet, August 1859," and represents the same two specimens, one of them now expanded. The net is broken into four parts and lies more or less flat. One part is apparently half the whole receptaculum, while each of the other parts consists of a basal arm and a small part of the net. The broken outspread receptaculum measures 24 cm. in diameter. The basal arms are six in number, and vary in length from 3 to 6 cms., and in breadth from 1·5 to 2 cms. The arms of the net are of the same breadth, and the oval meshes are only about 2 x 1·25 cms. The colour of the exterior is pinkish, with a red margin to the meshes, while that of the interior varies from pinkish at the base to deep red in the middle of the arms.

At the time my paper on the Phalloideae of Ceylon was published (Ann. Perad., IV., pp. 139–184), I had not seen expanded specimens of this species. "Eggs" had been gathered at Hakgala, but these did not develop further when brought to Peradeniya. These eggs were reticulated externally with furrows which divided the exterior into a series of close-set, flat-topped or rounded, polygonal tubercles. Their appearance was thus identical with that of the specimens obtained by Thwaites. This is the usual structure of the wall of the egg, and it apparently constitutes one point of difference between this species and *Clathrus cancellatus*. The furrows lie along the lines of attachment of the plates which traverse the internal gelatinous layer and extend to the bars of the net. A photograph of an egg was given in Ann. Perad., IV., Plate XIII.

This species, like *Aseroe rubra*, is not found at the elevation of Peradeniya (1600 ft.). Thwaites found it on Hantane, which is near Peradeniya, but about 2000 ft. higher. It has been collected on several occasions at Hakgala (5600 ft.), but always in a fragmentary condition. It is apparently not uncommon at an elevation of about 4000 ft., where it may occur during the rains on cultivated ground on tea estates; and in 1909–13, several examples were kindly sent me by Mr. G. Cameron, of Ythanside Estate, Kotagala. All expanded specimens were found in fragments. As it does not occur at Peradeniya, there have been no opportunities of observing it under natural conditions. A specimen, however, was sent me from Hakgala in the egg stage, and this expanded at Peradeniya, after being planted in a pot and covered by a bell jar. Photographs of this latter specimen were obtained and are reproduced herewith.

Plate XV (upper figure) shows the receptaculum, about two-thirds natural size, immediately after the rupture of the volva. Part of the volva is seen on the left, the inner side uppermost, and this shows clearly the polygonal arrangement of the white plates which traverse the translucent jelly. At this stage, the meshes of the net are comparatively small. It will be noted that although the expansion of the receptaculum has only just begun, it is already breaking up. The bars in the centre of the figure have broken across, disclosing the inner honeycomb structure, and another near the base is split half through.

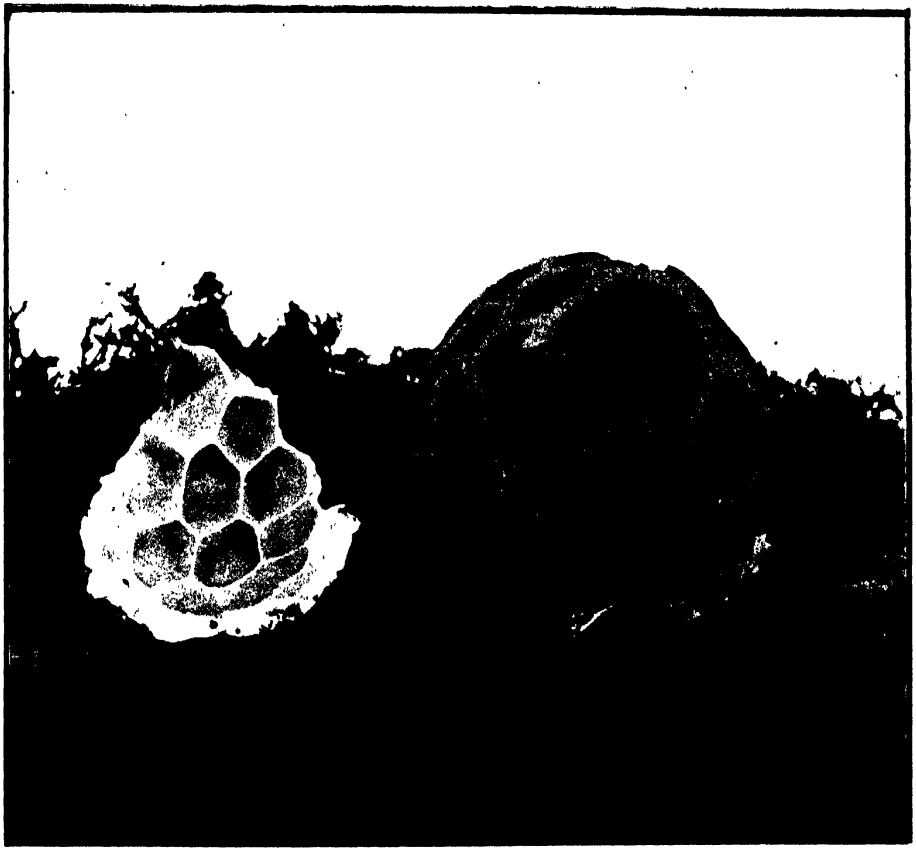
The final stage of expansion is seen in the lower figure, which is one half natural size. The upper part of the receptaculum has separated completely from the remainder, and lies to the right. The pale upper surface of that fragment is the *outer* surface, the curvature having been reversed during expansion. The remainder shows the red inner surface, the bars of the net being covered internally by the dark gleba.

Thwaites' specimen was collected in the egg stage, and evidently broke on expansion. The same happened with the present specimen. Moreover, all examples seen in the field have been in fragments. Hence it would appear doubtful whether the receptaculum of this species ever expands into a perfect net.

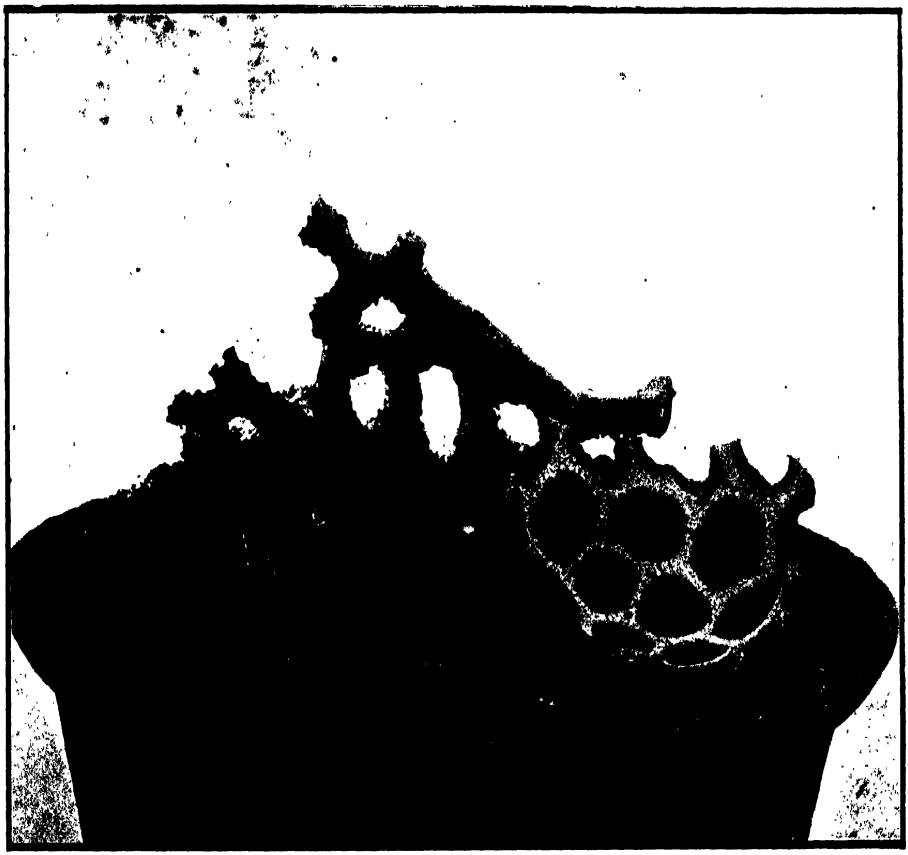
The net is pale pink externally, becoming deeper pink on the sides of the meshes, and deep crimson on the inner face of the bars. The bars are up to 2 cm. in breadth and 1 cm. thick in the middle, while the openings (meshes) are small, rounded or slightly polygonal, 1·2–2·2 cm. diameter. In cross section the bars are flat externally, sometimes rounded on the inner side, but more usually truncate-triangular, i.e., the section has the shape of an isosceles triangle with the apex cut off, the base of the triangle being outermost. The inner face is flat or slightly rounded, and is covered with a network of crimson ridges, while the sloping sides of the bars are slightly fluted. The dark olive gleba is confined to the crimson ridged area on the inner side of the bars.

The bars are composed of large irregular chambers in one or two layers, but the arrangement of the chambers is irregular. The walls of these chambers are perforated by minute crowded openings on the outer surface, and by larger more scattered openings on the inner face of the bars. Internally, the chambers communicate by large openings in their lateral walls, to such an extent that in places there appears to be only a series of struts from side to side within the bar. It is probably because of this excessive perforation that perfect examples have not been observed.

The mycelium is white, and its cords are up to 4 mm. in diameter. The spores are greenish hyaline, oblong with rounded ends, 4–5 x 2 μ.



Clathrus crispatus Thwaites, ×$\frac{1}{2}$



Clathrus crispatus, ×½.

Additions to Ceylon Fungi. III

BY

T. Petch, B.A., B.Sc.

HYMENOMYCETAE

Mycena illuminans P. Henn. On an Areca stump, Katugastota, July 3, 1922; No. 6479.

In the available specimens, both surfaces of the pileus glowed in the dark with a greenish light. The stalk was not luminous. The following is the description of the Ceylon fungus.

Pileus up to 12 mm. diameter, broadly convex, or plane with a decurved margin, umbilicate in the centre, hyaline, greyish in the centre, closely plicato-striate, slightly viscid, fragile, margin crenate. Stalk 2 cm. high, 1·2 mm. diameter, curved, slightly attenuated upwards, slightly expanded at the base, sub-translucent, minutely pruinose. Gills numerous, crowded, broad in front, attenuated for some distance behind, free; cystidia elongated oval, or subcylindric, 32 x 12 μ, sometimes suddenly attenuated into a curved beak, up to 12 μ long, 2 μ diameter, acute at the apex. Spores white, oval, 6–7 x 4–5 μ.

The Ceylon fungus agrees in general shape with Holtermann's figures of *Mycena illuminans* from Java, but Holtermann does not show the cystidia. von Höhnel stated that the Javan fungus had globose spores 8–9·5 μ, and cystidia 24 x 10–12 μ, cylindric-oval, and covered with cylindrical papillae, 2–3 μ long, at the apex.

Hebeloma siennaecolor Petch, n. sp. Pileus up to 6 cm. diameter, broadly convex, then plane or depressed in centre, margin repand, brownish red, smooth; flesh thin, white. Stalk up to 5 cm. high, 1 cm. diameter, equal, slightly bulbous at the base, white, longitudinally striate, hollow. Gills at first white, becoming ochraceous, somewhat distant, rather narrow, sinuate, with a decurrent line. Spores yellow-brown, oval, slightly inequilateral, 5–7 x 3·5–4 μ. On the ground, Peradeniya, April 1915: specimen and painting, No. 4609.

Hebeloma trachysporum Petch, n. sp. Clustered. Pileus at first conical, margin inrolled, then broadly conico-campanulate, 6 cm. diameter, yellow, slightly viscid, shining when dry, the cuticle cracking into minute

red brown areolae ; when old, red brown, minutely granular, margin paler ; flesh thick, yellow, becoming brown or red brown when old. Stalk up to 9 cm. long, 8 mm. diameter, rooting, at first pale yellow with red-brown dots and streaks, then red-brown, longitudinally streaked, pulverulent with scattered red-brown points, equal, or fistulose below, stuffed, yellow to red-brown internally. Gills pallid, then pale brown with a yellow edge, adnate with a strong decurrent tooth, broad (up to 7 mm.), attenuated outwards. No cystidia. Spores pale brown in mass, with a slight reddish tinge, yellow-brown by transmitted light, globose, 8–10 μ diameter, with large, irregular, flattened warts, up to 3 x 2 μ, sometimes arranged in lines and confluent. On a decaying palm stump, Peradeniya, July 11, 1909 : painting in Herb. Peradeniya.

Psalliota stadii Petch, n. sp. Pileus at first obtusely conico-campanulate, becoming broadly convex or plane, at first innately silky, shining, slightly viscid, the outer layer sometimes cracking into scales, white, slightly ochraceous in the centre, tinged purple when old, brittle, up to 6 cm. diameter ; flesh stout, white. Stalk stout, short, up to 3·5 cm. high, 1 cm. diameter, white or faintly yellowish, slightly innately fibrillose below, shining and silky striate above, with a central cavity stuffed with shining silky fibrils, or hollow, lined with silky fibrils ; partial veil stout, forming a descending curtain on the stem, no ring. Gills crowded, ventricose, or narrow and equal, free but close to the stem, pale purple brown, edge whitish ; spores purple brown, oblong-oval, 6 x 4μ. On the ground among grass, edible ; on the Golf Links, Peradeniya ; type specimen and painting, No. 6257. Near *Psalliota simulans* B. & Br., which differs in its more coloured pileus, arcuate gills, smaller spores, flesh changing colour when cut, etc.

Stropharia rostrata Petch, n. sp. Clustered. Pileus campanulate, up to 1·8 cm. diameter, with an abrupt, conical, obtuse umbo up to 2·5 mm. high, ashy, bay brown at the umbo, becoming bay brown elsewhere when sodden, slightly viscid when moist, margin feebly striate ; flesh thin, white, becoming brown and watery. Stalk up to 7·5 cm. high, 4 mm. diameter, straight or flexuose, pallid, becoming fuscous, longitudinally fibrillose, clothed up to the ring with scattered, minute, white scales, hollow ; ring soon disappearing. Gills adnate, or adnato-decurrent, attenuated outwards, crowded, pallid then pale purple. Spores in mass dark purple-brown, violet by transmitted light, narrow oval, smooth, 6–9 x 4 μ. Every part turning blue when bruised. On elephant dung, Hakgala, March 9th, 1922 ; No. 6381, with figure.

Panaeolus rubricaulis Petch, n. sp. Pileus conical, up to 1·4 cm. high, 1·8 cm. diameter below, blackish grey when moist, grey or brownish grey when dry, not viscid, smooth, or sometimes feebly reticulated in

the centre, atomate, margin pale, at first incurved, rarely appendiculate ; flesh thin, fragile, dull brown when moist, white when dry. Stalk up to 10 cm. high, 2 mm. diameter, red-brown to purple-brown, equal, smooth, base white tomentose, apex powdered with white ; no ring. Gills ascending, rather distant, ventricose, broadly adnate, grey, then blackened by the spores, margin white. Spores broadly elliptic, papillate with a hyaline papilla at each end, or lemon-shaped, brownish black, 12–15 x 8–12 μ. Cystidia on the edge of the gills flask-shaped, 24μ high, 8 μ diameter below, 4 μ diameter at the apex, apex slightly thickened. On manured ground, Peradeniya, November 9, 1922, etc. ; type specimens and painting, No. 6566.

There is apparently a specimen of this species in Thwaites 746 of September, November 1868, in Herb. Peradeniya, the remaining specimens being *Panaeolus cyanascens*. The stalk is red-brown always, not white at first.

Fistulina hepatica (Huds.) Fr. On a decaying tree trunk, Pedrotala galla, September, 1923 ; No. 6668.

Polyporus caesius Schrad. Hakgala, September 1923 ; No. 6671.

Fomes melanodermus Pat. Peradeniya, October 1923 ; No. 6713.

Fomes mesoleucus Petch, n. sp. Applanate, sometimes arising from an expanded basal tubercle, convex, orbicular, margin obtuse, purple black or blackish brown, somewhat mottled with purple brown here and there, especially towards the margin, upper surface irregularly rugose, matt, pore surface white. Context white, compact, hard ; cuticle very thin ; pores, in section, drying pale brown, and thus differing in colour from the context. Pores minute, 0·1 mm. diameter, 6 mm. long. Spores hyaline, globose, 6–8 μ diameter. On a dead stump, Warriapolla, December 1923 ; No. 6716. Available specimens up to 15 x 7·5 cms., and 2·5 cm. thick.

Mesulius gelatinosus Petch, n. sp. Resupinate, sometimes with a narrow, free, thin, rigid, upper edge, definite, in irregular patches up to 3 cm. long, 2·5 cm. wide, pale yellow, becoming ochraceous in drying ; hymenium well developed, labyrinthoid, sterile areas becoming white tomentose when dry, subgelatinous ; basidia 4–spored, cylindric, slightly inflated above, 3 μ diameter ; paraphyses clavate, slender, 2·5 μ diameter above, 2 μ diameter below, sometimes spinulose. On a dead mango branch, Peradeniya, June 1922 ; No. 6468.

Hydnum vagans Petch, n. sp. Mycelium forming stout cords overrunning decaying twigs, etc.; free cords rounded, 1 mm. diameter, tomentose, orange-yellow, becoming deeper orange where attached, expanding into irregular, membranous, separable, orange yellow patches, which bear terete, acute, rather distant spines, 1 mm. long, of the same

colour. On tea prunings, Ratnapura, August 1923 ; No. 6633. Similar in habit to *Poria rubrochorda* Petch, but differing in colour.

Corticium pervagum Petch, n. sp. Parasitic ; mycelium of stout, regular, septate, hyaline hyphae, 4–6 μ diameter, over-running and killing leaves and twigs ; hymenium forming diffuse, white, continuous, separable, powdery patches on leaves or stems ; basidia solitary or in groups on the basal hyphae, or lateral and terminal on short erect branches, sessile, pyriform, often transversely septate, 16 x 8 μ ; sterigmata tapering, 8 μ long ; spores ellipsoidal, somewhat inequilateral, hyaline, 5–8 x 3–5 μ. On *Erythroxylon coca* L., Peradeniya ; type, No. 6609.

Corticium penicillatum Petch, n. sp. Mycelium white, hypophyllous, spreading in flat strands up to 1 mm. broad, which divide at short intervals into a fan of radiating branches, one of which continues as the main strand, ultimately united by a thin film into a continuous sheet on which the basidia are developed. Hymenium white, almost continuous, forming a rather compact layer, 40 μ thick ; basidia at first lateral, then clustered, on short erect hyphae, pyriform or obconic or narrow-oval, 8–12 x 4–6 μ, four-spored ; sterigmata short, cylindric, 2 μ long ; spores hyaline, oval and inequilateral, or broadly cymbiform, 4–6 x 2·5–4 μ. On leaves of *Cocos nucifera* L., New Guinea, March 1924; parasitic.

Corticium invisum Petch, n. sp. Parasitic ; mycelium of hyaline; regular, septate hyphae, 4–6 μ diameter, over-running and killing leaves, and twigs of living plants ; hymenium forming thin, white, powdery patches, at first reticulated, ultimately continuous, usually on uninjured leaves ; basidia clustered, subglobose, 8–9 μ diameter, or ovoid, 9 x 7 μ sterigmata stout, attenuated above, up to 6 μ long, 1·5 μ diameter ; spores ellipsoidal, adherent, smooth, hyaline, 5–6 x 3–4 μ. On Tea, on which it causes the disease known as Black Rot in Ceylon ; also on *Oxyanthus tubiflorus* DC., *Hemidesmus indicus* Br., *Calophyllum Burmanni* Wight, and *Vernonia scariosa* Arn., Ceylon. Spores described from specimen on *Oxyanthus*, Henaratgoda, May 26th, 1917 ; No. 5332.

Heterochaete fimbriata Petch, n. sp.. Resupinate, determinate, circular, about 1 cm. diameter, or confluent in larger patches, livid grey when moist, livid brown when dry, subtranslucent, with scattered white points ; margin stout, furnished with somewhat distant, white, conical, fascicles of hyphae, up to 0·5 mm. long, decumbent on the substratum ; 0·5 mm. thick, internally subtranslucent, tough, compact, horny when dry, basal layer yellow-brown, hymenium pale brown ; processes cylindric, or slightly inflated above 55–66 μ high, up to 30 μ diameter, encrusted, especially at the apex, with irregularly globose masses of calcium

oxalate ; spores hyaline, oblong-oval, 8–10 x 3 μ. On wood, Peradeniya, November 1913 ; No. 3838.

Sebacina rufochracea v. Hohnel in litt., n. sp. Reddish ochraceous, effused, adnate, waxy ; margin white or yellowish, at first adnate, indeterminate, byssoid, recurving when old and revealing the brown glabrous under surface ; thickness up to 0·25 mm., sub-hymenial layer translucent, yellow-brown to red-brown, compact, followed by a loose hyaline tissue containing quantities of granules of calcium oxalate, and a compact yellow-brown basal layer ; basidia oval, 10 x 8 μ ; sterigmata narrow flask-shaped, up to 6 μ long ; spores hyaline, cylindric, curved, sometimes guttulate, 14–15 x 7 μ. On dead *Hevea brasiliensis*, Mariawatte, November 12, 1909 ; No. 3007.

Uredinaceae

Phragmidium subcorticium (Schrank.) Wint. On *Rosa*, cult., 1920 ; No. 6309.

Phycomycetae

Empusa apiculata Thaxt. On a fly and on a wasp, Vavuniya, Dec. 1923 ; coll. G.M. Henry, det. Thaxter.

Pyrenomycetae

Meliola calostroma (Desm.) v. H. On leaves of *Rubus moluccanus* L., Haputale, June 1917 (No. 5307) ; ditto, Hakgala, March 1922 (No. 6402) ; on leaves of *Rubus ellipticus* Sm., Hakgala, March 1922 (No. 6403).

Guignardia Opuntiae Petch, n. sp. Perithecia about 0·2 mm. diameter, gregarious, crowded, immersed, prominent, black ; asci clavate, 65 x 10 μ, spores biseriate ; paraphyses linear ; spores hyaline, continuous, cymbiform, ends obtuse, 15–20 x 4–5 μ. On *Opuntia Dillenii* Haw., Vavuniya, November 1915 ; No. 4786a.

Glomerella Gossypii Edgerton. On cotton, Nalande, April 1924.

Desmotascus Cinnamomi Petch, n. sp. Perithecia gregarious, up to 0·2 mm. diameter, immersed in the cortex, raising the epidermis in minute pulvinate elevations ; asci clavate, thick-walled above, 60–80 x 14–20 μ, embedded in hyaline tissue ; spores hyaline, continuous, lozenge-shaped, ends obtuse, 18–24 x 7–9 μ. On stems of *Cinnamomum zeylanicum* Bl., Southern Province, Ceylon, July 1922 ; No. 6526.

Wallrothiella episphaeria n. sp. Conidial stroma up to 5 mm. diameter, white, circular, thin, up to 0·3 mm. thick, plane, or elevated in the centre, of loosely intertwined hyphae 1–2 μ diameter, bearing

conidia laterally, sometimes with a palisade layer of erect basidia, up to 24 μ high, at the margin ; conidia hyaline, oval, ends acute, 3·5–5·5 x 2–3 μ. Perithecia crowded on the old conidial stroma in a continuous layer, adherent laterally but readily separable, at different depths, oval or pyriform, up to 0·2 mm. high, 0·12 mm. diameter, apex obtuse and slightly papillate, wall parenchymatous, black or greenish black ; asci clavate, attenuated below when mature, 32–42 x 4–5 μ, eight or sixteen-spored; spores oval or oblong-oval, ends obtuse, 3–6 x 1·5–2 μ, sometimes globose, 2 μ diameter. Parasitic on *Aglaospora aculeata* on *Camellia theifera*, Blackwood, Haputale, June 1924 ; No. 6779.

Botryosphaeria theicola Petch, n. sp. Stromata immersed, oval or circular, up to 0·6 x 0·4 mm., parenchymatous, black ; loculi irregularly globose, 120 μ diameter ; asci clavate, scarcely pedicellate, eight-spored, spores biseriate above, uniseriate below, 70 x 16 μ ; paraphyses numerous, linear, diffluent; spores hyaline, oval, 15–20 x 7–9 μ. On branches of *Camellia theifera* Dyer, Mahawale, 1918 ; No. 5739.

Botryosphaeria microspora Petch, n. sp. Stromata superficial, pulvinate, up to 2 mm. diameter, 0·75 mm. high, at first covered by a greyish white or purple grey tomentose film, becoming black, rough with close-set obtuse perithecia ; perithecia black, conoid, apex obtuse, 0·16 mm. high, 0·12 mm. diameter, embedded in the stroma for about one-third their height or rarely totally immersed, smooth, or with a few, rigid, spreading setae ; setae up to 50 μ high, 6 μ diameter, cylindric, septate, apex obtuse ; perithecial wall parenchymatous, thick, blackish brown in section, greenish above by transmitted light ; stroma internally soft, blackish brown, rather loose ; asci narrow-clavate, 30 x 5 μ, soon diffluent, eight-spored, spores uniseriate below, biseriate above ; spores oval or oblong-oval or sub-globose, hyaline, minutely warted, 2.5–6 x 2–3 μ, sometimes spuriously one septate. On old stems of tea, *Camellia theifera* Dyer, Diyagama, January 1924 ; No. 6730.

Botryosphaeria Erythrinae Petch, n. sp. Stromata subepidermal, oval or circular, about 1 mm. diameter, gregarious, united by loose hyphae in long linear patches, black, parenchymatous, ostiola not projecting ; loculi crowded, up to 0·25 mm. diameter ; asci 80 x 16 μ ; paraphyses filiform ; spores hyaline, continuous, lanceolate or narrow oval, ends obtuse, 18–24 x 5–6 μ. Some loculi are conidial, and contain Macrophoma spores, similar to the ascospores, 20–28 x 5 μ. On stems of *Erythrina lithosperma* Bl., Carolina, May 1918 ; No. 5718.

Anthostomella palmarum Petch, n. sp. Perithecia black, immersed, globose or laterally oval, 0·1–0·3 mm. diameter, scattered, or clustered in small groups and sometimes confluent; wall thick, parenchymatous ;

ostiolum conical, not projecting ; asci eight-spored, cylindrico-clavate, wall thin, 100 x 12 μ ; paraphyses numerous, diffluent ; spores ellipsoid or oval, biconvex, black, opaque, with a narrow pale line along the edge, 12–15 x 7–10 μ. On decaying spathe of *Cocos nucifera* L., Atale, June 1922 ; No. 6476.

Sordaria caerulea Petch. n. sp. Perithecia scattered, globose, 0·3 mm. diameter, totally immersed in a thin byssoid stroma which is at first bright blue, becoming black when dry ; ostiolum conical, prominent when dry ; wall membranous, violet by transmitted light, as are also the hyphae of the stroma ; asci cylindrico-clavate or fusoid, long-pedicelled, apex truncate, 180 x 12 μ, eight-spored ; spores at first hyaline, cylindric, sigmoidly curved, 40 x 4 μ, becoming fuscous, oval, inequilateral, 14–16 x 6–8 μ, with a basal hyaline appendage. On elephant dung, Hakgala, March 1922 ; No. 6376.

Mycosphaerella citrullina (C. O. Sm.) Gros. On *Luffa acutangula* Roxb., Peradeniya, August 1921 ; No. 6290.

Mycosphaerella Caricae Syd. On *Carica papaya* L., March 1920 ; No. 6183.

Mycosphaerella Camelliae Petch, n. sp. Perithecia hypophyllous, gregarious, prominent, about 160 μ diameter ; wall parenchymatous, fuscous ; ostiolum black ; asci thick-walled, attenuated upwards, 32 x 6 μ ; paraphyses wanting ; spores hyaline, narrow-oval or fusoid, medially one-septate, not constricted, ends acute, 6–9 x 1·5–2 μ. On leaves of *Camellia theifera* Dyer, with *Phyllosticta Theae* Spesch., Concordia, October 31, 1922 ; No. 6554. Apparently different from *Mycosphaerella Theae* Hara and *Mycosphaerella Ikedai* Hara.

Didymosphaeria Theae Petch n. sp. Perithecia immersed, 0·4 mm. diameter ; wall thin, parenchymatous, purplish ; asci cylindric, shortly pedicellate, eight-spored, spores uniseriate or slightly obliquely uniseriate, 100–110 x 8–9 μ ; paraphyses filiform ; spores oblong-oval, straight or slightly curved, equally one-septate, not constricted, olivaceous, 14–17 x 6–7 μ. On branches of *Camellia theifera* Dyer, Golinda, August 1918 ; No. 5791.

Leptosphaeria tornatospora Petch, n. sp. Perithecia scattered, immersed, becoming prominent, 150 μ diameter ; ostiolum 25 μ diameter, not projecting ; asci clavate, 80 x 12 μ, eight-spored, spores biseriate ; paraphyses numerous, linear ; spores brown, cylindric, five-septate, constricted at the septa, one cell often inflated, one end rounded, the other conoid, 16–24 x 5–6 μ. On dead twigs of tea (*Camellia theifera* Dyer), Keppooh, January 1923 ; No. 6572.

Actinodothis Piperis Syd. On leaves of Piper sp., Hakgala, February 1923 ; No. 6616.

Microdothella Theae Petch, n. sp. Stromata subcuticular, oval, up to 0.5 mm. long, 0.4 mm. broad, about 0.1 mm. high, flattened pulvinate, black, rugose, usually unilocular ; cover black, thin, breaking up irregularly in the centre, but radial towards the margin ; ostiolum circular, 30 μ diameter, not projecting ; stroma limited below by a very thin fuscous layer ; asci ovate or cylindric, with a short stout foot, thick-walled, spores biseriate, 50–70 x 20–24 μ; paraphyses united into a tissue between the asci, with septate, irregularly jointed, free tips, up to 3 μ diameter ; spores oval or ovate, hyaline, continuous, contents granular, 16–18 x 9–12 μ. On twigs of tea, *Camellia theifera* Dyer, Keppoch, January 1923 ; No. 6574.

Dermatodothis zeylanica Syd. On leaves of *Symplocos elegans* Thw., Hakgala, April 1917, No. 5232 ; on *Symplocos obtusa* Wall., Hakgala, March 1922, No. 6404, etc. ; on *Symplocos latiflora* Clarke, Hakgala, April 1919, No. 6005.

Rosenscheldiella Eugeniae Petch, n. sp. Spots circular, purple, up to 3 mm. diameter. Stroma thin, parenchymatous, fuscous, large-celled, cells more or less in vertical rows, situated between the epidermis and the mesophyll, base flat ; loculi erumpent, usually single, sometimes fused laterally, conoid or subglobose, 130–160 μ high, 100–160 μ diameter, black, rugose, cavity oval, about 100 μ high, 80 μ diameter ; asci obclavate, 72–76 x 13 μ, with a short foot ; no paraphyses ; spores hyaline, narrow cymbiform or narrow fusoid, one septate, ends obtuse, 24–32 x 4 μ. On leaves of *Eugenia subavenis* Duth., Hakgala, February 1923 ; No. 6615.

Lasionectria dothideicola Petch, n. sp. Perithecia gregarious or clustered, globose, up to 150 μ diameter, red-brown, collapsing, dark yellow brown by transmitted light, bearing a few, stout, yellow brown to blackish brown, rigid, thick-walled setae, 26–65 x 7 μ, at the apex ; ostiolum not elevated ; asci four or eight-spored, from 28 x 8 μ to 46 x 16 μ; spores oblong-oval or fusoid, one-septate, hyaline, 14–20 x 3–4 μ. On lax byssoid patches which bear Fusarium conidia, three-septate, curved, 36–46 x 2·5 μ, in pink masses. Parasitic on *Phyllachora hibisci* Rehm on *Hibiscus tiliaceus* L., Anuradhapura, March 1922 ; No. 6534.

Hypocrea Bambusae v. Höhnel, Sitzungsber. d. Akad. Wiss. Wien, M. n. K., Abt. I., Bd. 129, p. 152 (1920). Stromata superficial, scattered or gregarious, at first globose, then somewhat flattened, with a strongly contracted base, white, then yellow, sordid red-brown when mature, with a matt, almost smooth surface, up to 1·3 mm. diameter,

internally yellow, fleshy, cortex pale yellow-brown. Perithecia ovate-pyriform, conical above, 120 μ diameter, 200–250 μ high ; ostiolum 28 μ diameter, not or only slightly projecting ; paraphyses scanty, slender, not diffluent ; asci cylindric, shortly stalked and attenuated below, 60–70 x 3 μ, apex not blue with iodine ; part-spores hyaline, shortly globoso-cylindric, guttulate, 2.5–3.2 x 2.5–3 μ. On bamboo, Peradeniya, 1907, coll. von Höhnel. If the part-spores are smooth, this species differs from those previously described from Ceylon.

Hypocrea cincta Petch, n. sp. Stromata dark red-brown or purple-brown, circular, subdiscoid, up to 1 cm. diameter, 3 mm. thick, upper surface plane or convex, sides rounded, attached over two-thirds the base, fleshy when fresh ; when dry, hard, minutely verrucose, internally purplish white, contracting so that the sides slope inwards and the perithecial layer extends beyond the lower part of the stroma and is demarcated by a furrow; perithecia in a single layer, globose, 0·25–0·3 mm. diameter, or laterally oval, 0·3 x 0·25 mm., wall yellow-brown : asci 90 x 4 μ ; spores green or blackish green, dark green in mass, globose, 3·5–4 μ, or cuboid, 5 x 3·5 μ, minutely verrucose. On dead wood, Hakgala, March 1922 ; No. 6373.

Begins as a white, pulvinate, tomentose stroma, which becomes discoid and turns red-brown from the centre outwards, the margin and sides remaining white for some time. Probably the species which Berkeley and Broome referred to *Hypocrea rufa* from Ceylon.

Trichopeltula Hedycaryae Theiss. On leaves of *Scolopia crassipes* Clos. (No. 6396) and *Cinnamomum ovalifolium* Wight (No. 6400), Hakgala, February, 1922.

Acrospermum minutum P. Henn. On leaves of an undetermined jungle tree, Gonakelle, April 1924 ; No. 6762.

The specimens are larger, 1·8 mm. high, than given by Hennings (0·5 mm.).

Discomycetae

Niptera epiphytica Petch, n. sp. Generally hypophyllous, superficial, sessile, without evident stroma or on a thin, white mat of hyphae, yellow or orange yellow, centrally attached, up to 0·8 mm. diameter, 0·25 mm. high, disc flat or slightly concave, externally smooth ; asci clavate, thick-walled, 50 x 10 μ, apex not blue with iodine ; spores oblong-oval, ends obtuse, one-septate, not constricted, hyaline, 5–8 x 1·5–2 μ; paraphyses simple, 1·5 μ diameter, expanding above into an oval head, 8 x 5 μ. On living leaves of *Psychotria, Sarcococca, Murraya*, etc., which it does not injure, Hakgala ; type on *Psychotria*, Hakgala, March 1922.

Gorgoniceps marginata Petch, n. sp. Superficial, attached by a slight weft of white, radiating hyphae, sessile, urceolate, with a broad spreading margin ; height 0·3 mm., total diameter 0·5 mm., diameter below the rim, 0·3 mm. ; disc red-brown ; rim 0·15 mm. broad, white, pruinose with masses of calcium oxalate, convex ; externally red-brown, slightly white pruinose ; wall red-brown, 0·025 mm. thick, of parallel hyphae ; asci cylindric, 130 x 6–8 μ, apex thickened and sometimes with a cylindrical pore extending nearly to the apex, apex not blue with iodine ; paraphyses numerous, linear ; spores linear, as long as the ascus, septate, 1·2 μ diameter. On living leaves of *Hedyotis Lessertiana* Arn., Hakgala, January 1914.

Stictis emarginata Cke. & Massee. On leaves of *Eucalyptus robusta* Sm., Diyagama, August 1922 ; No. 6493.

Patellaria purpurea Petch, n. sp. Sessile, broadly concave, up to 2 mm. diameter, margin irregular, incurved ; at first dark reddish purple, becoming purple-black, internally greenish yellow ; outer layer of wall about 0·1 mm. thick, opaque, crumbly, followed by a hyaline layer, 0·05 mm. thick ; mass of asci greenish yellow, disc opaque in section ; asci cylindrico-clavate, 220 x 10 μ, apex blue with iodine ; paraphyses fused above ; spores hyaline, narrow oval, 3–4 septate, thick-walled, not constricted externally, the loculi strongly constricted internally, septa thin, 16–24 x 5–8 μ. On dead twigs of *Acacia melanoxylon* R. Br., Hakgala, March 1922 ; No. 6525.

Atichia Millardeti Rac. On *Cinnamomum Loureiri* Nees (No.6385), *Eurya japonica* Thunb. (No. 6386), *Scolopia crassipes* Clos. (No. 6387), Hakgala, February-March, 1922.

Endogone nuda Petch, n. sp. White, pulvinate, up to 1 cm. diameter, 4 mm. high, tomentose, without definite cortex : hyphae 8 μ diameter, expanding to 20 μ below the chlamydospores ; chlamydospores globose, 90–160 μ diameter, or pyriform, up to 170 x 150 μ, wall 5–12 μ thick. Dry specimens are yellowish white, with an outer layer of hyphae and immature chlamydospores, 0·25 mm. thick ; internally granular, mottled, chlamydospores sordid yellow-brown, separated by pale yellow hyphae ; no central cavity. On matted rootlets at the margins of streams in the jungle, Hakgala, February 1923 ; No. 6598.

Sclerocystis alba Petch, n. sp. Stromata white, externally matted tomentose, hard, laterally ovoid, up to 1 mm. long, 0·8 mm. broad, 0·6 mm. high, aggregated and fused together in pulvinate masses ; internally white, with scattered red-brown asci ; hyphae of stroma hyaline or faintly yellowish, thick-walled, much branched, 8–16 μ diameter ; asci yellow-brown (by transmitted light), thick-walled (wall 6–8 μ thick),

globose, 80–88 μ diameter, or broadly ellipsoidal, 72–95 x 64–80 μ. On the ground among dead leaves, Hakgala, February 1923; No. 6600.

DEUTEROMYCETAE

Phyllosticta Theobromae d'Alm. & Cam. On *Theobroma cacao* L., Peradeniya, September, 1922; No. 6544.

Phyllosticta Theae Spesch. On *Camellia theifera* Dyer, Concordia, October 1922, No. 6555: Diyanila Kele, January 1923, No. 6573.

Phyllosticta Carica-papayae Allesch. On *Carica Papaya* L., Kandy, May 1924.

Phoma glumarum Ell. & Tr. On *Oryza sativa* L., Peradeniya, March 1920; No. 6185.

Plenophysa adiposa Petch, n. sp. Superficial, hemispherical, or convex, circular or oval in plan, up to 4 mm. diameter, dark purple brown, with a dull matt surface, glabrous, becoming lenticular, wrinkled, black, sometimes with a narrow, white, byssoid hypothallus, up to 0·1 mm. wide; internally blackish in mass, soft, viscid, subtranslucent, by transmitted light yellowish white with a thin outer brown cortex; cortex amorphous, reddish brown to black, with a few collapsed spores; basal layer thin, of hyaline hyphae 2 μ diameter; hypothallus consisting of a hyaline basal membrane containing a network of fine hyphae, 1–2 μ diameter, with a superficial layer of similar hyphae, loose and bearing globose hyaline conidia, 2–3 μ diameter, laterally; interior a mass of cohering hyaline, thin or thick-walled spores, oval, 6–10 x 4–6 μ, or globose, 7 μ diameter, with a few hyaline hyphae, 1–3 μ diameter, on which the spores are borne laterally, and large crystalloids of calcium oxalate up to 64 x 50 μ, which frequently include spores. The spores are united by a fatty (?) substance which dissolves in chloroform. Frequent at Hakgala on leaves of *Sarcococca pruniformis* Lindl., *Psychotria* sp., *Microtropis Wallichiana* Wight, etc.; also from Travancore, Nov. 8, 1908.

Plenophysa nitida Petch, n. sp. Superficial, oval in plan, up to 0·75 mm. long, 0·5 mm. wide, pulvinate or sub-turbanshaped, up to 0·4 mm. high, black, smooth, shining, even or slightly lacunose above; wall slightly brittle, 0·1 mm. thick, opaque, containing here and there brown hyphae 4 μ diameter, visible after treatment with caustic potash, and lined with brownish to hyaline, thick-walled hyphae 2 μ diameter; internal mass brown, somewhat loose and shrinking from the wall when dry, consisting of hyaline, continuous, oblong-oval spores, 2–3 x 1 μ, borne laterally on hyaline hyphae, 1 μ diameter, irregularly interwoven. On leaves of *Borassus flabellifer* L., Peradeniya, June 1913; No. 3664.

Phomopsis Theae Petch, n. sp. Pycnidia immersed, lenticular, oval in plan, up to 0·4 mm. long, 0·25 mm. broad; wall black, parenchymatous; ostiolum oval, 40 x 25 μ; A conidia narrow-oval or lanceolate, acute at one end, 6–8 x 1·5–2 μ; B conidia linear, flexuose or strongly hooked, 18–24 x 0·75 μ. On twigs of *Camellia theifera* Dyer, Keppoch, January 1923; No. 6587.

Macrophoma Theae Spesch. On leaves of tea, *Camellia theifera* Dyer, Dalkeith, June 1923; No. 6628.

Dothiorella Anonae Petch, n. sp. Stromata subepidermal, black, flattened pulvinate, about 0·3 x 0·2 mm., parenchymatous; loculi circular or oval in plan, up to 150 μ diameter; conidia hyaline, continuous, narrow oval, sometimes inequilateral, or subfusoid, ends usually obtuse, 18–22 x 5 μ. On twigs of *Anona Cherimolia* Mill., Hakgala, February 1923, raising and cracking the epidermis, ultimately falling out; No. 6604.

Cytospora Theae Petch, n. sp. Pycnidia immersed, circular or irregularly oval, 0·2–0·4 mm. diameter, usually clustered, black, simple or incompletely chambered; wall thin, parenchymatous; spores hyaline, oblong-oval, 3–5 x 1·5 μ; basidia variable, usually short, some simple, up to 24 μ long, a few branched, up to 32 μ long. On stems of *Camellia theifera* Dyer, Golinda, August 1918; No. 5789.

Coniothyrium Theae Petch, n. sp. Pycnidia amphigenous, minute, 50–60 μ diameter, black, erumpent, wall parenchymatous; ostiolum small, 5 μ diameter, furnished with periphyses; spores oval, pale fuscous, 2–3·5 x 1·5–2 μ. On leaves of *Camellia theifera* Dyer, with *Macrophoma Theae* Spesch., Dalkeith, June 1923; No. 6628.

Ascochyta Theae Hara. On *Camellia theifera* Dyer, Hemingford, April 1922; No. 6409.

Ascochyta rosicola Sacc. On *Rosa* cult., Peradeniya, October 1919; No. 6127.

Hendersonia confluens Petch, n. sp. Pycnidia 0·1–0·15 mm. diameter, erumpent, black, rugose, conoid, ostiolate, confluent or crowded on a black stroma in flat or flattened pulvinate groups up to 5 mm. diameter; wall parenchymatous, thick; basidia about 12 μ long; spores oval, two-septate, the middle cell fuscous or pale brown, the terminal cells hyaline and collapsing, 10–13 x 4–5 μ. On stems of *Erythrina lithosperma* Bl., Yataderia, June 1922; No. 6471.

Hendersonia macrospora Petch, n. sp. Pycnidia immersed, black, globose, 0·2–0.4 mm. diameter, usually clustered; basidia 8–16 μ long; spores oblongo-fusoid, thin-walled, three to five-septate, ends obtuse, hyaline then pale brown, 30–40 x 7–8 μ. On branches of *Camellia theifera* Dyer, Golinda, August 1918; No. 5790.

Hendersonina Saccharl Butler. On *Saccharum officinarum* L., Peradeniya, June 1921 ; No. 6269.

Septoria Lycopersici Speg. On *Lycopersicum esculentum* Mill., Peradeniya, January 1921 ; No. 6239.

Leptothyrium Theae Petch, n. sp. Pycnidia immersed, black, oval, up to 0·35 mm. long, 0·1–0·2 mm. broad, wall parenchymatous, opening by a longitudinal slit ; basidia narrow flask-shaped, 6–12 μ long , spores narrow-oval or subfusoid, hyaline, continuous, sometimes spuriously one-septate, ends usually acute, 5–8 x 1·5–2 μ. On stems of *Camellia theifera* Dyer, Hatnagalla, September 1917 ; No. 5357.

Gloeosporium piperatum Ell. & Ev. On Chillies (*Capsicum*), Peradeniya, May 1923 ; No. 6617.

Gloeosporium Opuntiae Ell. & Ev. On *Opuntia Dillenii* Haw., Vavuniya, Nov. 1915 ; No. 4786.

Colletotrichum nigrum E. & H. On Chillies (*Capsicum*), Peradeniya, May 1923 ; No. 6618.

Colletotrichum brachytrichum Delacr. On leaves of *Theobroma cacao* L., Pallekelle, April 1922 ; No. 6391.

Colletotrichum Ricini Petch, n. sp. Acervuli erumpent, flattened pulvinate, up to 0·3 mm. diameter, or confluent in large masses, pale brown ; conidia cylindric, ends obtuse, straight or slightly curved, 14–20 x 3.5–5 μ ; setae dark brown, straight or slightly flexuose, obscurely septate, apex subacute, base not inflated, 70–120 x 4–5 μ. On stems of *Ricinus communis* L., Peradeniya, November 1913 ; No. 3903.

Colletotrichum Dracaenae Petch, n. sp. Amphigenous, chiefly epiphyllous ; acervuli at first immersed, black, then erumpent, pale brown, oval, up to 0·3 x 0.12 mm.; spores hyaline, cylindric, ends rounded, 16–20 x 3·5–4 μ ; setae tardily developed, dark brown, obtuse, obscurely septate, often flexuose, strongly curved, not inflated below, 32–80 x 3–4 μ. On leaves of *Dracaena Sanderiana*, causing large, dark brown patches, Peradeniya, May 1924 ; No. 6775.

Colletotrichum Cordylines Pollacci has setae 124 x 7–8 μ. No spore measurement was given, but the spores are said to be " subaequilongis." If the latter term means equal in length to the setae, it is clearly a different species.

Melanconium palmarum Cooke. On *Cocos nucifera* L., Peradeniya, November 1921 ; No. 6354.

Pestalozzia Theobromae Petch, n. sp. Spots irregular, more or less orbicular, dark brown to blackish brown, faintly zoned, surrounded

by a narrow, pale green border ; acervuli epiphyllous, circular, 0·15 mm. diameter, or elongated, 0·3 x 0·15 mm. ; spores fusoid, four-septate, with three central coloured cells, triciliate, 15–20 x 5–7 μ (without pedicel or cilia) ; coloured cells 12–16 μ long ; pedicel about 4 μ long ; cilia short, up to 12 μ long. On leaves of *Theobroma cacao* L., Pallekelle, April 1922 ; No. 6392.

Pestalozzia disseminata Thuem. On leaves of *Eucalyptus* sp., Bunyan, December 28, 1921 ; No. 6451. Spots grey ; acervuli amphigenous, chiefly hypophyllous ; spores (without pedicel or cilia) 21–26 x 4–7 μ ; three coloured cells, 15–17 × 5–7 μ ; basal hyaline cell, 4–6 μ ; apical hyaline cell, 3–4 μ ; cilia 8–16 μ long ; pedicel, 4–6 μ long.

Pestalozzia Piperis Petch, n. sp. Spots large, orbicular, white or grey, with a narrow black margin ; acervuli amphigenous, chiefly epiphyllous, gregarious, towards the margin of the spot, black, circular, 0·2 mm. diam., lenticular ; spores fusoid or subcymbiform, four-septate, with three central coloured cells, not or slightly constricted, triciliate, (without pedicel or cilia) 17–22 x 4–5 μ ; three coloured cells, 10–15 μ long ; basal cell, 2–3 μ long ; pedicel, 2–4 μ ; apical cell, 3–5 μ long ; cilia, 4–10 μ long. On leaves of *Piper nigrum* L., Peradeniya, Feb. 3, 1917 ; No. 5051.

Pestalozzia Flacourtiae Petch, n. sp. Spots large, orbicular, grey or brownish grey above, with a purple margin, pale brown below, closely concentrically zoned on both surfaces ; acervuli epiphyllous, minute, 0·1 mm. diameter, pycnidiiform, opening by a minute pore ; spores fusoid or subcymbiform, four-septate, with three coloured central cells, not or slightly constricted, three or four ciliate, (without cilia or pedicel) 20–28 x 6–8 μ ; coloured cells, 14–18 μ long ; basal cell, 3–4 μ long ; pedicel 4 μ ; apical cell, 2–4 μ long ; cilia 12–20 μ long, up to 1 μ broad at the base, rather rigid. On leaves of *Flacourtia inermis* Roxb., Peradeniya, February 21, 1915 ; No. 4503.

Pestalozzia Vanguerae Petch, n. sp. Spots more or less circular, red-brown, obscurely zoned. Acervuli epiphyllous, subepidermal, then widely open, up to 0·2 mm. diameter ; spores fusoid or subturbinate, straight or curved, four-septate, with three central coloured cells, 16–24 x 7–8 μ, triciliate ; coloured cells 12–16 μ long ; basal cell, 3–4 μ long : pedicel, 4 μ ; apical cell, 2–4 μ ; cilia, 4–14 μ. On leaves of *Vangueria edulis* Comm., Peradeniya, February, 1915 ; No. 4504.

Pestalozzia Cinnamomi Petch, n. sp. Spots circular, grey, with a narrow purple margin. Acervuli chiefly epiphyllous, subepidermal, becoming widely open, up to 0·2 mm. diameter ; spores fusoid or subcymbiform, four-septate, with three central coloured cells, the lowest frequently paler than the other two, two or three ciliate, 15–18 x 6–8 μ ;

coloured cells 10–15 μ ; basal cell, 3 μ ; pedicel 4 μ ; apical cell 1–3 μ ; cilia 4–12 μ. On leaves of *Cinnamomum zeylanicum* Bl., August 1907 ; No. 2501. Also on *Litsea fuscata* Thw., Hakgala, May 1912 ; No. 3501.

Piricularia Oryzae Cav. On *Oryza sativa* L., Gangaruwa, May 1922 ; etc. On *Panicum repens* L., Gangaruwa, May 1922.

Ramularia areolae Atk. On cotton, Nalande, April 1924.

Cladosporium superficiale Petch, n.sp. Hypophyllous, forming black, circular, superficial, floccose patches, about 1·5 mm. diameter ; conidiophores up to 100 μ high, 4 μ diameter, equal, regular, septate, black or fuliginous ; conidia usually fusoid or cylindric, one end rounded, the other acute, fuliginous, three-septate, rarely four-septate, 14–20 x 4–5 μ, with a few, one-septate, oval, 8 x 5 μ. On leaves of *Cinnamomum ovalifolium* Wight, Hakgala, February 1922 ; No. 6570.

Differs from *Cladosporium congestum* B. & Br. in colour, and in the shape of the hyphae and conidia.

Acrothecium lunatum Wakker. On *Sorghum vulgare* Pers. ; Peradeniya, June 1921 ; No. 6291.

Actinostilbe, gen. nov. Stilbacearum. Synnemata cylindrica, sursum in disco, a paraphysibus cincto, expansa ; conidia hyalina uniseptata.

Actinostilbe Vanillae Petch, n. sp. Synnemata erumpent, cylindric, up to 0·3 mm. high, 0·2 mm. diameter, expanding above into a fringed disc, 0·3 mm. diameter ; disc sometimes almost sessile ; stalk of parallel agglutinated hyphae, yellow ; disc whitish, convex ; marginal paraphyses yellow-brown, up to 100 μ long, 4–6 μ diameter, septate, minutely spinulose, terminating in an oval or clavate tip 6–10 μ broad ; basidia up to 18 μ long, 2 μ diameter, fusoid, attenuated above, clustered at the apices of the conidiophores ; conidia apical, solitary on a slender sterigma, hyaline, oblong-oval, ends obtuse, one-septate, 5–8 x 2 μ. On stems of *Vanilla planifolia* Andr., Peradeniya, May 1922 ; No. 6454.

Graphium cylindricum Petch, n. sp. Solitary, or connate at the base in groups, arising directly from the substratum or from a byssoid stroma, up to 1·5 mm. high, more or less cylindric, slightly inflated above, 0·2 mm. diameter ; stalk black, dark-brown by transmitted light, continued as a columella almost to the apex ; head greyish white, rather loose, peripheral layer more or less discontinuous ; conidiophores spreading, stout, 3 μ diameter, suberect or curving out and becoming horizontal, up to 130 μ long, repeatedly branched, the upper branches whorled and about 12 μ long, pale fuscous, bearing one or more conidia on short sterigmata ; conidia pale fuscous, narrow-oval, ends obtuse, 5 x 2·5 μ. On dead wood, Peradeniya, June 1921 ; No. 6272.

Didymobotryum atrum Pat. var. **pachysporum** Penz. and Sacc. On *Oncosperma*, Peradeniya, August 1921 ; No. 6288.

Arthrobotryum infundibuliforme Petch, n. sp. Up to 0·8 mm. high, black, head grey ; stalk of fused parallel hyphae, 32 μ diameter below, 16 μ diameter above, arising from a brown disc of hyphae united laterally ; head oval, up to 80 μ high, 60 μ diameter, the outer layer of the stalk hyphae terminating about half way up the head and forming a pale brown funnel enclosing the conidiophores ; conidia hyaline, becoming pale fuliginous, narrow-oval or fusoid, one to three-septate, ends acute, 14–20 x 3–3·5 μ. On leaves of *Cinnamomum ovalifolium* Wight, Hakgala, February 1922 ; No. 6568.

Tubercularia leguminicola Petch, n. sp. Sporodochia superficial, pink, waxy, compact, scattered or clustered, up to 0·5 mm. diameter ; parenchymatous base small or almost absent ; conidiophores 50 μ high, branched dichotomously above, the ultimate branches 16 μ long, 2 μ diameter, subfusoid, acute ; conidia hyaline, 4–6 x 2 μ, narrow-oval. On pods of *Bauhinia* sp., Peradeniya, Oct. 1923 ; No. 6729.

Bactridium album Petch, n. sp. Sporodochia pulvinate, white or cream coloured, minute, circular, up to 0·5 mm. diameter ; conidia hyaline, clavate, thin-walled, multiseptate, apex rounded, 90–120 x 12–13 μ. On decaying wood, Hakgala, February 1923 ; No. 6611.

Epicoccum Theobromae Petch, n. sp. Spots white, subtranslucent ; acervuli hypophyllous, black, shining, minute, up to 0·15 mm. diameter, or confluent in patches; conidia circular, 5–6 μ diameter, or oval, 6 x 5 μ, dark fuscous, smooth. On leaves of *Theobroma cacao* L., Peradeniya, September 1922 ; No. 6545.

Chaetostroma viride Petch, n. sp. Stromata minute, up to 0·25 mm. diameter, pulvinate, black, surrounded by setae at the base ; setae up to 150 μ high, 6 μ diameter below, tapering upwards, apex acute, thick-walled, septate, pale green ; conidia dark green in mass, pale green separately, oval, ends acute, 3–5 x 1·5–2 μ ; conidiophores up to 30 μ high. On twigs of *Camellia theifera* Dyer, Mooloya, May 1922 ; No. 6433.

Spegazzinia meliolicola P. Henn. On a *Meliola* on *Memecylon*, Peradeniya, August 1913 ; No. 6571.

Notes on Ceylon Clavariae

BY

T. Petch, B.A., B.Sc.

Clavaria miniata Berk.

Berkeley described this species, from South Africa, in Hooker's London Journal of Botany, II (1843), p. 416, the description being "parva, cinnabarina, stipite tenui attenuato in clavulam palmato-subifidum compressiusculum sursum incrassato. On sandy ground among mosses." Subsequently, he recorded it from Ceylon, among the fungi sent by Gardner, Gardner No. 30, but it was not recorded by Berkeley and Broome among the fungi sent by Thwaites, more than twenty years later.

There is no difficulty in determining which Ceylon species was intended. It is a very common Clavaria which occurs all over the wet low country and up to at least an elevation of 4000 ft. during the rains, in large patches, always on well-trodden footpaths. It apparently does not occur on loose soil, or on sand or gravel paths, but on bare, compact, clay-like soil, *e.g.*, estate footpaths. Gardner's specimen is marked "On the ground in open places."

As already stated it was not recorded from Thwaite's collection. But it is so common and of so regular occurrence that it is scarcely possible that it was not included. In fact, it is Thwaites' No. 67, which was assigned by Berkeley and Broome to *Clavaria argillacea* Fr. and *Clavaria inaequalis* Fr. With regard to the specimens assigned to the latter species, Berkeley and Broome stated "Exactly the form figured by Greville. Spores 0.00015 (inches)." The spores of the Peradeniya herbarium specimens of Thwaites 67 are 8–10 by 4–5 μ, but the specimens are mouldy and numerous other foreign spores are present.

Whether the Ceylon species is identical with the South African has not been ascertained. The former is sometimes flattened and expanded at the apex, but in general it is not, and its habitat would appear to be different from that of the South A'rican species.

The Ceylon species is gregarious, growing in troops, but usually not fasciculate, 5 mm. to 3 cm. high, 1–1.5 mm. diameter, fusiform or linear,

cylindric, straight or flexuose, sometimes curved and twisted, simple, apex obtuse, sometimes flattened above and 2–3 mm. broad, orange-red, becoming pinkish red when dry, internally the same colour, sometimes orange yellow at first in very wet weather; hyphae of the context, 2–4 μ diameter; basidia clavate, 4-spored, 24–36 by 4–6 μ; sterigmata hair-like; 6 μ long; spores white, pinkish in mass, 8–14 by 3.5–5 μ, oblong-oval or somewhat clavate, with an excentric apiculus.

This does not appear to differ from *Clavaria helicoides* Pat. and Demange, from Tonkin. The dimensions of the spores of the latter are not given. M. Demange, who saw the Ceylon species growing at Peradeniya, stated that the Tonkin species differed in being always curled and twisted. The Ceylon species is straight as a rule, but in drier weather some examples are curled and twisted.

I have not been able to trace this species among the Javan Clavariae described by Van Overeem.

Clavaria laeta B. & Br.

This species grows on the ground among grass. It resembles *Clavaria fusiformis* in shape, but is orange red, coral red, or blood red.

Fasciculate, simple, connate at the base, up to 9 cm. high, 2–4 mm. diameter, fusoid, attentuated above and below, the larger specimens compressed and sulcate, apex obtuse, slightly tomentose at the base, stuffed, internally red or pink throughout; basidia cylindrico-clavate, 4-spored, 30–45 by 4–6 μ; sterigmata awl-shaped or elongated conical, 7–10 μ long; spores white, spherical or subglobose, 4–5.5 μ, usually with a short stout apiculus, about 0.6 μ, long.

Van Overeem's figure of *Clavaria sanguineo-acuta* (Icones Fungorum Malayensium, Plate III, fig. 8) exactly represents small examples of *Clavaria laeta*.

Clavaria vermicularis Fr.

Fasciculate in groups of three or four, white, waxy, up to 6 cm. high, cylindric, up to 3.5 mm. diameter, or compressed, up to 4.5 mm broad, attenuated towards the base, equal or attenuated at the apex, simple, often longitudinally sulcate, sometimes irregularly forked, internally white, stuffed; spores white, oval, 5–6 by 3 μ.

This species occurs among grass in the Palm Grove at the entrance of the Royal Botanic Gardens, Peradeniya, in company with *Clavaria fusiformis* and *Clavaria laeta*, but appears more rarely than either of those. It was apparently not collected by Thwaites.

Clavaria fusiformis Sow.

This was recorded for Ceylon by Berkeley and Broome from Thwaites

678, 680, *cum icone*. It grows among grass in company with *Clavaria laeta* and *Clavaria vermicularis*. The colour varies with weather conditions and age between chrome yellow, orange yellow, lemon yellow, and pale yellow. In drier weather the clavae acquire a whitish bloom, but they regain their original colour when placed in a damp chamber.

Fasciculate, up to 9 cm. high, 2–3 mm. diameter at the base, 5 mm. in the middle, exceptionally 16 cm. high, 1 cm. diameter, fusiform, terete, or flattened and sulcate, simple, apex acute or obtuse, sometimes crested with a few short points in small examples, internally pale yellow, or chrome yellow becoming paler in the centre, stuffed then hollow; hyphae in the centre of the clava up to 8 μ, diameter, minutely verrucose; basidia clavate, 4-spored, 18–24 by 6–8 μ; sterigmata conical, 3–6 μ high, 1 μ diameter at the base; spores white in mass, spherical, 4–7 μ diameter, with a cylindrical apiculus.

In the Ceylon, form the apex is usually the same colour as the remainder of the clava, but it may turn brown in old specimens. Thwaites' figure shows the clavae with brown tips.

Clavaria vermiculata Micheli.

Simple, solitary or fasciculate, clavate or almost equal, terete, up to 5 cm. high, 2 mm. diameter, apex abruptly conical or obtuse, tapering towards the base, white, apex becoming translucent, glabrous and shining at the base, dull above, brittle; spores white, broadly oval or subglobose, 5–8 by 3–5 μ, apiculus terminal. On the ground, Peradeniya.

Clavaria subaurantiaca Henn. & Nym.

Fasciculate, up to 10 cm. high, 5 mm. diameter, fusiform, frequently curved, twisted and irregularly fistulose, laterally compressed and longitudinally sulcate, apex usually subacute, often rounded, dull orange or reddish orange, internally orange, stuffed becoming hollow, base strigose; spores pale yellow in mass, globose, 4–6 μ diameter. On the ground among grass, Peradeniya.

? **Clavaria luteo-tenerrima** Van Overeem

Simple, gregarious, up to 5 cm. high, 0.5–1 mm. diameter at the base, soon expanding upwards to 1.5–3 mm. diameter, terete, sometimes flattened and sulcate, apex obtuse; small specimens curved, about 1.5 cm. high, 1 mm. diameter at broadest; at first pale yellow, translucent, then orange yellow, sometimes reddish orange and horny-looking at the base, becoming orange red on drying, internally fibrillose, yellow; spores white in mass oblong oval, 6–9 by 4–5 μ, with a large sublateral

apiculus. On the ground among dead leaves, Peradeniya ; No 2950. July 11, 1909 ; etc. Stains paper yellow.

Clavaria zylogena B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 684, as " Simplex, pusilla, albida, acutissima, pulverulenta, e communi basi fasciculatim oriunda (No. 675). On dead wood, Peradeniya, July 1868. Dispersed in little scattered fascicles, or more rarely single, ½ inch high. Spores elliptico-subfusiform, .0005 long, .0002 wide."

The fungus is up to 5 cm. high, 0.5 mm. diameter, simple, or once branched above, or sometimes dividing into a cluster of erect branches, fasciculate, adjacent clavae frequently fused, cartilaginous, white or brownish white, internally pale brown, subtranslucent ; spores white, oval, apiculus oblique, 12–15 by 6–7 μ. Specimens have been collected on bamboo, Peradeniya, November 1914 ; No. 4310.

This species is a Pterula, and will stand as *Pterula xylogena* (B.and Br.).

Clavaria xylarioides Petch

The specimens described under this name resemble in shape those figured by Van Overeem as *Clavaria fusco-lilacina* Berk. (Icones Fungorum Malayensium, Plate II, fig. 4). Only simple examples have been found, and they differ in colour from the latter species, being violet-black, black at the base, instead of violet light brown, or dark brown violet, ochre brown at the base. The basidia and spores are also different. The species at first sight might be taken for a Xylaria or a Geoglossum.

Clavaria violacea Petch

As pointed out by Van Overeem, this species is probably identical with that identified by him as *Clavaria Zollingeri* Lév. One would, however, scarcely describe it as roseo-amethystina. Lévéille described *Clavaria Zollingeri* as " Pedicule court, nu, irrégulier ; les rameaux peu nombreux, étalés, d'une belle couleur rosée tirant sur le violet. La division dichotomique des rameaux," etc. Van Overeem translates this as " äste wenig zahlreich, dichotom verzweigt ; Stiel kurz und glatt und Farbe rosa, übergehend in schön violett." The latter version may, as he states, agree well with the species he regards as *C. Zollingeri*, but it has not the same meaning as the original.

Clavaria Zippelii Lév.

In Fungi of Ceylon, No. 673, Berkeley and Broome recorded *Clavaria formosa* Fr., from Thwaites 552 and 676 in part, giving the localities

" South of the Island, July 1868 ; Central Province, Dec. 1868." In No. 674 of the same list, they described *Clavaria Thwaitesii* B. & Br.. " Trunco crasso, ramis pluries divisis apicibus fuscis ; sporis subglobosis (No. 552). Central Province, Dec. 1868 ; Damboul, March 1868."

After *Clavaria Thwaitesii*, Berkeley and Broome added the note, " Exactly the form of *Clavaria formosa*, but the spores in that species are broadly fusiform and granulated. No. 676 is a variety with the division more as in *C. stricta*. Spores subglobose, even, with a large nucleus, 0.00035 in diameter (i.e., 9 μ). Under the same number from the South of the Island, July 1868, is a still more strongly divided form, with a narrow stem, but the spores exactly the same."

It will be noted that, although Berkeley and Broome referred to No. 676 as a variety of *C. Thwaitesii*, they cited that number for *C. formosa* only. Similarly the specimen from the South of the island is mentioned under *C. Thwaitesii*, but that locality is cited only for *C. formosa*.

As far as I was able to discover, there is no Ceylon specimen of *Clavaria formosa* in the covers of that species in Herb. Kew. The specimens, Thwaites 552 and 676, five sheets, are all included under *Clavaria Thwaitesii*. All these, including the strongly divided form, have oval or pyriform, warted or echinulate spores, with a few globose and echinulate. In Herb. Peradeniya, the specimens, Thwaites 552, have the same spores. There are also in Herb. Peradeniya, sections of a large specimen, up to 12 cm. high, with long straight terete branches, which are probably parts of the strongly divided form noted by Thwaites ; the stalk appears narrow, but it is really a section of the stalk which has curled up in drying. These latter specimens are loose, and are not accompanied by any Thwaites' number, but the paper in which they are contained is marked " Clavaria sp. Thwaites coll." by J. B. Carruthers. These specimens have the same spores as Thwaites 552 and 676 in Herb. Kew.

In Herb. Peradeniya, there is a sheet marked by Thwaites, 676, S. of the Island, which is totally different from any of the foregoing. The specimens grew on wood, and are up to 5 cm. high. They divide almost from the base, repeatedly at a narrow angle, into slender branches about 1 mm. diameter, the tips of the ultimate branches being penicilliate with several rather long slender processes. The spores are hyaline, smooth, broadly oval, 5–7 by 4–5 μ, or globose, 5–6 μ, with a short cylindrical apiculus. I have not noted this form in Thwaites 676 in Herb. Kew, and it is clear that this cannot be *Clavaria Thwaitesii*, as it does not in the least resemble *Clavaria formosa*. Evidently there has been some confusion of specimens.

There does not appear to be any specimen in the type of *Clavaria*

Thwaitesii in Herb. Kew which has globose smooth spores. There is a possibility that such may be found in the Broome collection in Herb. British Museum. But on the specimens examined, *Clavaria Thwaitesii* B. and Br. is identical with the specimens assigned to *Clavaria formosa*. Moreover, these are not *Clavaria formosa*, but *Clavaria Zippelii* Lév.

Clavaria Zippelii has been collected recently at Peradeniya and Hakgala. It differs considerably in degree of development. Some forms are about 6 cm. high, with a stem about 1 cm. diameter, which divides at about half the height of the fungus into several stout branches. the angle of branching is small, and the outer branches usually curve upwards so that all the branches are more or less parallel. These branches, in the smaller forms, divide above into a few stout, terete, more or less conical, obtuse points. In larger specimens the main branches may divide repeatedly at a wider angle, the ultimate branches terminating in the same manner as described above. In other cases, the tips at the ends of the stout branches are prolonged into terete branches, up to 3 cm. long, either simple, or shortly forked at the apex; these branches all stand erect and form a more or less compact bundle.

The fungus is fawn-coloured or greyish brown, with blue or greenish-blue tips. Internally it is white, turning purplish when cut. The mycelium is white, and becomes slightly purple when handled. The spores are yellow-brown, usually unequally pyriform, or pyriform and curved at the narrow end, sometimes oval, sometimes globose, strongly echinulate with spines up to 2 μ long, or merely verrucose. The pyriform spores are paler, and less spinulose, or almost smooth, at the narrow end. The oval and pyriform spores measure 10–16 by 6–8 μ; the globose spores are about 8 μ diameter.

The blue tips are a marked feature of this fungus in Ceylon, whether the stumpy form with short tips or the taller form with proloned tips. Van Overeem (Bull. du Jardin Botanique, Buitenzorg, Ser. III. V. p. 278) criticises Von Höhnel's statement regarding the blue tips of this species at Buitenzorg, and declares that a blue colour is scarcely ever to be seen on the specimens which now occur there. Van Overeem states that he has never found forms with beautiful blue tips among the numerous examples he has seen, and that blue tips occur only on completely "ausgewachsen" examples; the specimens in the Botanic Gardens, Buitenzorg, are never "ausgewachsen," and therefore their tips are not blue. This is quite at variance with the behaviour of this species in Ceylon.

Clavaria fragillima Sacc. & Syd.

Coralloid, up to 14 cm. high; main stem stout, 8 mm.–2 cm. diameter, dividing above repeatedly at an acute angle, ultimate branches

short, terminating in a few conical divaricating points ; in smaller specimens, sometimes dividing abruptly into numerous comparatively slender branches, which are shortly divided at the apex and terminate in smaller points ; base clothed with white mycelium which turns purple when bruised ; in the larger specimens, brownish with a purple tinge below, ochraceous or orange above, in the smaller specimens, entirely ochraceous or orange ; internally white, becoming purplish when cut ; spores ochraceous in mass, yellow brown by transmitted light, narrow oval, or fusoid and inequilateral, pointed at one or both ends, strongly spinulose, 9–12 by 4–5 μ. On the ground, Hakgala ; No. 2661, September 1908 ; No. 4118, September 1914.

The colour of the Ceylon specimens is much brighter than that of Van Overeem's figure (Icones Fungorum Malayensium, Plate I, fig. 3), and the figure does not show clearly the divaricating tips which are a marked feature of the Ceylon fungus and distinguish it from all forms of *Clavaria Zippelii*.

Clavaria megalorhiza B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 675, as " ochracea multifida e mycelio radiciformi oriunda, apicibus acutis ut plurimum penicillatis ; sporis ochraceis (No. 197). On wood. Central Province, Dec. 1868. About 1½ inch high." Some of the specimens in the type in Herb. Kew grew among dead leaves, etc. One has a stout stalk ; the others are thin and clustered, bound together by mycelium below ; one has a long mycelial strand attached.

The fungus is bushy, arising from a single short stout stem, or from several stems which are bound together by a sheet of mycelium. The stems divide repeatedly, usually from near the base, at an acute angle, the upper branches often being broadly expanded at the point of division. The ultimate branches terminate in a cluster of erect terete processes, a few millimetres long. The total height is up to 4.5 cms. and the diamater up to 2.5 cms. The colour is white, often with a purplish tinge, becoming yellow brown when old. The spores are yellow brown in mass, pale yellow brown by transmitted light, oval, oblong oval, or subpyriform, spinulose or minutely verrucose, 5–7 by 3–5 μ in a spore print from fresh specimens. On the old herbarium examples the spores are 5–6 by 3 μ, frequently cohering in fours.

Thwaites 1004 was assigned by Berkeley and Broome to *Clavaria byssiseda* Pers. The specimens have a taller main stem than those of Thwaites 197, but they are the same species. Thwaites 1005, which was assigned to *C. stricta* P. is again the same species ; the specimens grew among dead leaves and some individuals arise from a sheet of mycelium.

Among the fungi collected by Beccari in Ceylon, Cesati described *Clavaria intricata* Ces., as " Ochrospora, cervina, 1½ inch alta, caespitosa, ramosissima, ramis tenuibus, flexousis, intricatis, apicibus saepius penicillatus." It would seem probable that this is identical with *Clavaria megalorhiza* B. & Br., but I have not seen the type specimen.

Clavaria megalorhiza grows on the ground, often among dead leaves, or on very rotten wood. In the latter case it arises from coarse, but lax, white, rooting mycelium, the strands of which are up to 4 mm. diameter.

Clavaria echinospora B. & Br. and C. **semivestita** B. & Br.

Clavaria echinospora B. & Br. was described as " Repetiter furcato-ramosa, a mycelio stipitiformi oriunda, sicca nigra, sporis ellipticis echinulatis. Peradeniya, July 1868." The description was followed by the note " Undoubtedly allied to the last (*C. megalorhiza* B. & Br.); but the spores are larger and the whole plant becomes black when dry. No. 677 (Peradeniya, July 1868) seems, however, to be a variety of *C. megalorhiza*, which becomes darker in drying. Spores broadly elliptic, strongly echinulate, .0002–.00025 long, .0001–.00015 broad." This spore measurement refers to *C. echinospora*.

Clavaria semivestita B. & Br. was described as "Fasciculata ochracea ramis cylindricis furcatis, e trunco tenui oriundis, deorsum tomentosa ; apicibus acutis (No. 677 in part). On the ground. About 1 inch high. Half the plant is covered with short down."

It will be noted that no Thwaites' number is cited for the type of *C. echinospora*. In Herb. Peradeniya, *C. echinospora* and *C. semivestita* are on the same sheet, which is marked on Thwaites 677, Central Province. Peradeniya is in the Central Province, but in Thwaites' lists, Central Province usually means a locality other than Peradeniya, and frequently Hakgala. In Herb. Kew, the only specimen under *Clavaria echinospora* is No. 677, marked " *C. echinospora* B. & Br. *Clavaria macrorhiza* B. & Br. var. Peradeniya, July 1868." (Berkeley and Broome wrote " macrorhiza " on the herbarium specimens, but published the name as " megalorhiza "). Consequently, either the type of *C. echinospora* is missing, or Berkeley and Broome's note under that species is incorrect, in that it relates to the type, not to another specimen. The latter appears to be the true explanation. Other specimens of Thwaites 677 are included in Herb. Kew under *Clavaria semivestita*, and there is a further specimen, *sub C. megalorhiza*, marked in pencil, Ceylon, 677, *ex* Herb. Currey, which is also *C. semivestita*.

Clavaria echinospora B. & Br. Bushy, forming more or less depressed-globose tufts up to 10 cm. diameter and 7 cm. high, arising either from a

single stem or a cluster of stems ; stems up to 5 mm. diameter, terete or compressed, soon dividing repeatedly and more or less dichotomously at an acute angle on the inner branches, but at a wide angle on the more horizontally spreading outer branches ; ultimate branches on fully developed examples long, terete, tapering regularly, simple or bifid, apex usually subacute ; immature branches often flattened at the apex and crested with a few conical processes ; cartilaginous, somewhat subtranslucent, pallid or brownish below, pale purple or lilac above, slightly white tomentose at the base, elsewhere with a glaucous bloom, becoming black on drying ; spores white in mass, coarsely spinulose with short broad-based spines, or coarsely tuberculate, or nodular, oval, 4–7 by 3–4 μ. Frequent at Peradeniya, on the ground among grass.

Van Overeem has suggested that *Clavaria echinospora* is identical with *Clavaria Zippelii*, in spite of the fact that scarcely a single detail of the description is applicable to the latter. He finds support for his suggestion in Berkeley and Broome's statement that the spores are larger than those of *Clavaria megalorhiza*, but he has misinterpreted their reference and has assumed that the spore measurement given under *Clavaria echinospora* is that of *Clavaria megalorhiza*. Moreover, *Clavaria echinospora* has hyaline spores, not brown spores.

Clavaria echinospora is probably identical with the Javan species assigned by Van Overeem to *Clavaria implexa* Lév., though, if so, his figure on the latter (Icones Fungorum Malayensium, Plate I, fig. 3) scarcely represents correctly the long straight tips. Unfortunately, Van Overeem does not give any indication that he has examined the type specimens of Javan fungi, and consequently his references to these ancient species are doubtful. As is well-known to all who have taken the trouble to look up the old type specimens of fungi, they frequently do not correspond with the description and may even not have been placed in the correct genus.

Clavaria semivestita B. & Br. Up to 4.5 cm. high ; clustered, in groups of three or four, or in tufts up to 3 cm. diamater ; primary stem terete, up to 3 mm. diameter, but usually thinner, soon dividing above at a wide angle, each branch dividing dichotomously about twice, axils often rounded ; tips usually simple, acute or obtuse, sometimes up to 1 cm. long ; white, then brownish, yellow brown when old, minutely pruinose to varying heights, tips glabrous ; when dry, minutely tomentose and rufous or pale brown below, glabrous and dark brown above ; spores white in mass, hyaline by transmitted light, smooth, globose, 5–7 μ diameter, with a cylindric apiculus up to 2 μ long. On the ground among grass ; frequent at Peradeniya.

The tomentose covering, from which Berkeley and Broome derived the

name, is not noticeable until the specimens have been dried. *C. semivestita* apparently resembles *C. alcicornis* Zoll. et Mor.. as re-described by Van Overeem, but it is white at first and the brown colour is not due to the spores.

Clavaria candelabrum Massee

Bushy, up to 6 cm. high, waxy, pallid or brownish white, sometimes slightly purplish at the base ; main stem stout, sometimes branching almost from the base, sometimes continuing as a central stem for half the height of the fungus, giving off distant lateral branches ; branches arising at a wide rounded angle, often decurved from the point of origin, then curving upwards vertically, expanding upwards, and dividing into a cluster of thinner branches with the same wide rounded angle, this mode of branching being repeated two or three times until the branches terminate in a cluster of slender conical processes arranged exactly as the lower branches ; base strigose with brown mycelium which forms a pad over the substratum; the whole fungus brown to blackish brown on drying, spores white, globose, 3–4 μ diameter, or oval 3–4 by 2–3 μ. On dead wood, Hakgala.

Well-grown specimens of this species are remarkably regular. The primary branches bend downwards in a wide curve, and then turn upwards into a vertical position, becoming parallel to one another. At about the same height, all these divide into secondary branches, with exactly the same curve, which form a broader cluster of parallel vertical branches ; and this is repeated two or three times, forming successive tiers of parallel branches. I have not seen the type specimen of *Clavaria candelabrum*, but the name is irresistible.

Epipogon nutans

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

Epipogon nutans Lindl. was formerly common in the shrubberies of the Royal Botanic Gardens, Peradeniya, and especially so in the Nutmeg Grove, where the ground was covered with a thick carpet of decaying leaves. The best specimens I have seen, however, and the largest number at one time, have been on cacao estates in Dumbara, where it luxuriates in pockets filled with decaying leaves among the roots of the cacao.

As recorded in the Flora of Ceylon, the scape may be up to 20 inches high and one-third of an inch in diameter. It arises from one end of a pale yellow brown, ovoid or oblong-ovoid tuber, which may be up to 3 inches long. The tuber (Plate XVI, fig. 3) lies horizontally in the soil, and the larger specimens are somewhat flattened ; it is encircled at intervals of two or three millimetres by more or less parallel lines, which, as stated in the description of the plant in the Flora of Ceylon, are leaf scars. These lines mark the nodes. The tuber is a shortened rhizome, with internodes two to three millimetres long. For the sake of clearness, the term tuber will be retained for this organ, and the term rhizome employed for a different structure.

The scape (Plate XVI, fig. 1) is white and somewhat translucent. It bears adpressed membranous scale leaves below. The flowers are similarly white and subtranslucent, or sometimes spotted with red. The plant has no roots and no true leaves. When in flower it consists of a tuber and a flowering stem only. The tuber is solid at first, but as the scape develops it becomes hollow. Similarly the developing scape is solid at first, and becomes hollow as it increases in height. When flowering is completed, the tuber is collapsed and only an empty shell is left. After flowering, nothing of the parent plant remains alive. That has been determined repeatedly from examples flowered in pots, as well as from plants in their natural habitat.

At an early date in my residence in Ceylon, some observations were made on this plant, and it was intended to carry out further investigations, but for various reasons these were never undertaken. Some data were, however, obtained, and these are recorded here to direct attention to a few peculiar features in the life history of this species which require elucidation.

Small tubers, about 2 cm. long and 1 cm. diameter, which have not begun to flower, bear membranous scale leaves at the nodes toward the apex, or growing point. The scale leaves of one node do not extend over the next node, *i.e.* they are not more than two or three millimetres long. In addition, the nodes bear a dense fringe of hairs. Further back towards the base of the tuber, the same fringe of hairs is present at the nodes, but the scale leaves have for the most part disappeared, and only their bases persist. The scale leaves are so thin and small that they are not discernible until the tuber is examined carefully. They are free, and can be lifted up with a needle. The scale leaf bears numerous hairs on its outer surface, and the same hairs occur more sparingly over the internodes.

The hairs are up to 2 mm. long, generally simple, but sometimes with a septum towards the base, hyaline at first, becoming yellow brown, rough and often irregular at the tip. They resemble root hairs. They stain brown with chor-zinc-iodide, even in the young stage on the rhizome which will be referred to later, and are evidently cuticularised. Owing to the presence of these hairs the surface of the tuber is slightly matted tomentose, but this is not a conspicuous feature. Similarly hairs also occur on the scale leaves on the flowering stem and on the bracts.

Fungus hyphae occur among the hairs, but are comparatively scanty. They vary from hyaline to purple brown, and in diameter from 2 to 4 μ though occasionally one may be up to 10 μ diameter. The purple brown hyphae are for the most part regular, but here and there geniculate. Hyphae are present in the scale leaves and in the epidermal layer of the tuber, but they rarely occur in the hairs. No hyphae have been observed in the living cells of the interior of the tuber.

If the tuber has not begun to flower, all the parenchyma cells are so completely filled with starch that a cut surface appears granular. In general, the cells are so densely filled with starch that it is not possible to see anything else in them without further treatment. Towards the exterior, for a depth of about three cells, some do not contain starch, while in the others it is less abundant than in the deeper lying tissue.

Here and there, small brown masses of cells, three or four cells deep, extend from the exterior into the tuber, sometimes, but not always, from a node. These cell groups are traversed by a few stout hyphae, usually

distant from one another. There are no masses of hyphae in these cells; They appear to be dead, and the hyphae merely saprophytic.

Larger tubers which have begun to flower do not present many external differences from the foregoing. Scale leaves may still be present near the apex. The hairs, in general, do not contain hyphae. Hyphae are more abundant than on the smaller tubers, and form a wide-meshed network over the surface. Sometimes a thin membranous sheet composed of hairs and hyphae stretches across the furrow which forms at a node as the tuber becomes exhausted. Under a low magnification, small scattered reticulated patches may be observed on the internodes; these are formed by fine strands of agglutinated hyphae. But there is no dense weft of hyphae over the tuber, and no strands visible to the naked eye.

As the plant flowers, all the starch is consumed, and the tuber becomes hollow and finally collapses (Plate XVI, fig 1.).

The rhizome referred to below, bears hairs similar to those on the tuber. Hyphae occur among these hairs, but have not been observed within them, or within the rhizome.

The habitat of the plant is first revealed by the appearance of a scape. If the dead leaves are then cleared away, other examples will often be found, some in the early stages of flowering, others which have not yet begun to flower. Thus the tubers are frequently gregarious. Moreover, it was noted on several occasions that in the Nutmeg Grove, where the soil was not disturbed by cultivation,three or four tubers would lie in the same straight line. Further, the tuber frequently has a short appendage, apparently the remains of a dead rhizome, at the basal end (Plate XVI, fig. 2). These facts appeared to point to the existence of some connection between the tubers at some stage of their development.

On one occasion, a tuber was found which had begun to produce a scape, but the upper part of the latter had been broken off. As the tuber was solid, it was evident that the scape had not developed to its full extent before the injury occurred. From near the basal end of the tuber there arose a small white tuber, and a thin white rhizome 24 cm. long. This rhizome was slightly more than 1 mm. in diameter, and showed ten nodes at intervals of 2 to 2.5 cms. It was white, slight hairy with a fluffy whorl of hairs and a developing tuber at each node. The developing tubers arose laterally at the nodes, each in the axil of a small membranous scale leaf, and in three instances they had grown on at the apex, thus forming a lateral branch with a basal swelling.

These rhizomes were subsequently observed on several occasions. Once, three weeks after the dead leaves in the Nutmeg Grove had been swept back, three examples were found near a flowering tuber. One

tuber, 1.8 cm. long and 1 cm. diameter, with eight rings, bore two young white tubers, from each of which a white rhizome about 5 cm. long had grown. Another, 1.2 cm. long and 1 cm. diameter, with indistinct rings, had produced a rhizome about 1 cm. long and 2 mm. diameter. Another bore three developing rhizomes. The rhizomes (Plate XVI, Figs. 4, 5) are 1–2 mm. in diameter, and may arise anywhere on the tuber; most of them are lateral, but some may originate near the base of the damaged flowering stalk and are then almost terminal. They may emerge directly from the tuber, or a small sessile tuber may be first produced which passes into a rhizome at its apex. Sometimes a sessile tuber and a rhizome originate at the same point. Rhizomes are similarly produced by pieces of tubers which have been cut up during digging operations.

The developing scape, which in each case was in the "hook" stage, was cut off three tubers which were then planted in a pot among decaying leaves. Eleven days later, the largest was producing three rhizomes, and the other two, three and two respectively. Three months later it was found that the old tubers had decayed, and numerous white rhizomes with minute lateral tubers were lying free among the leaf mould, but these young tubers were only 1–2 mm. diameter. Subsequently they decayed.

In one of the examples noted in the foregoing paragraph, a rhizome arose from the flowering stalk near the cut surface.

Four tubers, varying from three to four centimeters in length, which had not yet begun to flower, were taken, the conical apex, about 5 mm. long, cut off each, and the tubers then planted in pots, being half embedded in soil and then covered with decayed leaves. Three weeks later only the largest (A) showed the points of developing rhizomes. As the soil conditions appeared unsuitable, these were modified by embedding the tubers in decayed leaves above the soil. In another fortnight, two small sessile tubers, 2–3 mm. diameter, had developed on A, and another (B) had begun growth. After two months, A had produced a long rhizome which could not be followed without damage; B had produced a strong rhizome; but C and D still did not show any growth. After three months, A had two rhizomes, 1.5 mm. diameter, which bore developing tubers up to 4 mm. diameter, and a cylindrical, elongated tuber 11 mm. long, 5 mm. diameter, arising at the point of origin of one of the rhizomes; B had a rhizome, 7.5 cm. long, 2 mm. diameter, with small developing tubers at the nodes; A and D were just starting to produce rhizomes. After five months, the old tuber of A had disappeared and small tubers were present; B had a rhizome 22.5 cm. long; C had two rhizomes, one 7.5 cm. and the other 16 cm., both bearing developing

tubers; D had also two similar rhizomes. The pots were not examined again for another five months. Nothing was then found in any of them except in A, which contained one tuber, 1.8 cm. long, 1.1 cm. diameter. with eight rings. This was replanted, but when examined again a month later, it was found to have developed another rhizome. 11.5 cm. long; this rhizome developed from the apex of the tuber, *i.e.* in the position of the scape.

From a tuber, 3 cm. long and 1.5 cm. diameter, the developing inflorescence, 3 cm. high, was cut off, and the tuber suspended in a beaker of water, so that the basal 5 mm. was immersed. Ten days later, two rhizomes were appearing, and after seventeen days, nine had been produced, one from each of the internodes above the water. The two lowest internodes which were immersed in the water did not produce a rhizome. The rhizome from the uppermost internode remained small, about 2 mm. long; that from the second internode was about 1 cm. long; that from the third 1.5 cm., with a developing tuber 1 cm. from the base; that from the fourth about 2 cm. long; that from the fifth, 3 cm. long, extending to the water, with two developing tubers; that from the sixth, 1 cm. long, but with two tubers; that from the seventh, 5.5 cm. long, with two tubers, and a swollen base, 2.5 mm. diameter; that from the eighth 3.5 cm. long, with two developing tubers; that from the ninth, 5 cm. long, with two developing tubers. These rhizomes were arranged in a two-fifths phyllotaxy. The swollen bases of the rhizomes and the nodes were clothed with radiating hairs up to 2 mm. long, and the same hairs were scattered along the internodes. These hairs exhibited active protoplasmic streaming.

The foregoing specimen was left for a fortnight longer, during which time the rhizomes lengthened further. At the same time a white mycelium began to develop from the base. Pustules of Cephalosporium and Fusarium then arose all over the tuber, and these were followed by the perithecia of a Nectria. This proved to be *Nectria haematococca* B. & Br. (*Nectria Bolbophylli* P. Henn.), which is the common Ceylon Nectria on decaying vegetable matter.

Thus if the growing point of a tuber of *Epipogon nutans* is cut off, or if, after it has begun to flower, the scape is removed, the tuber will produce one or more long white rhizomes, 1–2 mm. diameter, on which new tubers are produced laterally. Obviously, this procedure is abnormal. The rhizome and the new tubers are produced at the expense of the old tuber, but under normal conditions that does not occur, the whole of the contents of the tuber being utilised in the production of the inflorescence.

The problem arises, what is the place of the rhizome in the normal

life history of the plant. From the occurrence of the plant as a single tuber, it might be supposed that the seed on germination produced a plantlet which straightway develops into a tuber. That would be comparable with the development of many green-leaved orchids. In that case there would be not any rhizome at any stage of the plant's life history. Alternatively, the seedling might develop directly into a rhizome which bears tubers laterally, the rhizome decaying before the tubers are mature, but in that case one would expect to find these rhizomes among decaying leaves independent of mature tubers. It would appear that this can be decided only by growing the plant from seed.

A specimen in which the emerging scape had attained a height of 3 cms. was dug up and planted in a pot indoors. The apex was then, as usual, decurved, and about 7 mm. long. Four days later, the scape was 3.4 cm. high, but the decurved bud had grown to 2 cm. long. After seven days, the height of the scape was 4.2 cm. and the length of the decurved bud 2.9 cm. It was then covered with a bell glass. Four days later, it had attained a height of 14.5 cm., with a horizontal apex, 3 cm. long, the lower flowers having opened, and in another four days, it had become erect and 26 cm. high. Growth in the earlier stages was most probably retarded by unfavourable conditions.

On one specimen which was under observation during its actual flowering period, three flowers opened on the first day, three on the second, four on the third, two on the fourth, two on the fifth, two on the sixth, and one (the last) on the seventh. The fruits of the flowers which opened on the first and second days dehisced six days, those of the third day five days, and the remainder four days, after the opening of their respective flowers. This early dehiscence of the fruits is in striking contrast to that which obtains in other Ceylon orchids, *e.g.* in *Saccolabium longifolium*, in which dehiscence of the fruits does not occur until they are about twelve months old, and it is no doubt to be correlated with the early decay of the plant after flowering.

Flowering is not dependent upon the size of the tuber. Small tubers, 2 cm. long, may produce a scape and then die. But the size of the tuber governs the dimensions of the scape.

Groom examined specimens of *Epipogon nutans* from Java, but his results differ from those recorded above. He found that the tuber was covered by a densely matted mass of fungus hyphae, and that the scale leaves were so firmly fused to the tuber, except at their apices, that they could be separated only by chemical means. According to that, the external layers of the tuber are formed by adherent scale leaves, not by stem tissue. On Ceylon specimens, however, the scale leaf can be lifted up with a needle and, with a little care it can be detached together with

a strip of the epidermis of the next internode below ; it is then clear that the outer layer of the internode differs from the tissue of the scale leaf the latter having elongated cells down the centre, while the former is composed of isodiametric cells.

Groom further states that the hairs have thin, non-cuticularised walls and indubitably function as root hairs and that many of them, contain fungus hyphae which are presumably mycorhizal in nature. But in the Ceylon specimens the hairs rarely contain hyphae and their walls are cuticularised.

The figure of the starch distribution in the tuber, given by Groom, is apparently that of a tuber which has begun to flower. In a non-flowering tuber, the whole section stains black with iodine. The small-celled tissue shown in his fig. 2, Plate 6, occurs only near the apex of the young tuber.

Groom considers that the scales are the absorbing organs of the plant ; the mycorhizal hyphae enter the hairs and occupy all the cells of the scales, and the substances absorbed by the hairs are transported to the bases of the scale leaves and thence into the tuber. But in Ceylon the hairs rarely contain hyphae, and the scale leaves disappear so soon that it would seem improbable that they could function in the manner suggested.

In several respects, the behaviour of *Epipogon nutans* is parallel to that of *Gastrodia elata*, as described by Kusano. The scape of the latter plant develops from the apex of an isolated tuber, which bears nodal scars as in *Epipogon nutans*, but its scale leaves soon disappear, and it is destitute of hairs. In general, the flowering tuber of Gastrodia does not show any mycorhiza. The flowering tuber attains a length of 10 to 17 cms., and there is always a large number of small tubers, down to 2 mm. diameter, lying round it. After flowering the tuber dies.

The non-flowering tubers of Gastrodia give rise to shortly-stalked tubers, or to long rhizomes which bear similar tubers. In the absence of any mycorhiza, these tubers are nourished at the expense of the parent tuber, and consequently they are progressively smaller in successive generations, until they die. This is exactly similar to *Epipogon nutans*, except that, in the latter, the production of daughter tubers appears to be dependent upon the destruction of the growing point of the parent tuber.

According to Kusano's investigations, the rhizomorph of *Armillaria mellea* furnishes the mycorhiza of *Gastrodia elata*. If the rhizomorph comes in contact with a young tuber of the Gastrodia, its hyphae may enter the latter and form an endotrophic mycorhiza. This tuber then increases in size, and constitutes a mycorhizal mother tuber, which

however does not flower, but produces numerous, non-infected, daughter tubers, some of which may develop to a sufficiently large size to produce a flower, while the remainder reproduce vegetatively by offsets and rhizomes, and become smaller with each succeeding generation, unless they happen to become infected by an Armillaria rhizomorph.

Thus, all the nutriment of the Gastrodia is obtained by the mycorhizal mother tuber and is transferred to the flowering and non-flowering daughter tubers. The former do not contain any mycorhiza and hence cannot obtain any food independently, and the majority of the latter are in the same case.

Kusano states that in some instances the Armillaria mycelium behaves as a parasite and destroys the Gastrodia tuber, while in others it forms an endotrophic mycorhiza.

Though Kusano's investigations establish the existence of a mycorhiza within some of the tubers of *Gastrodia elata*, there are several points in his account which appear to require further elucidation. In the circumstances stated, it would seem that it should be an easy matter to discover the mycorhizal mother tubers, and to observe the development of the flowering tubers from them, but from his account it would appear that they have rarely been found, and when found their daughter tubers have not been developed to the flowering stage. His account of this stage of the life history of the plant is consequently largely hypothetical, and is based simply on the fact that mycorhizal tubers can produce daughter tubers,—a faculty which is not confined to mycorhizal tubers only in *Gastrodia elata*. The hypothesis would explain the absence of mycorhiza from the flowering tuber, but the evidence adduced does not appear to support it. It may be noted that Kusano's figure of a mycorhizal tuber producing daughter tubers (Fig. 14) appears to represent a tuber, of which the apex has been destroyed.

Further it is somewhat extraordinary that the daughter tubers so frequently fail to become infected. Kusano states that a great majority of the tubers are always free from the fungus.

Attempts to discover a mycorhizal mother tuber in *Epipogon nutans* have not been successful.

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EXPLANATION OF PLATE XVI

Fig. 1. *Epipogon nutans*, flowering specimen (part of stem omitted); tuber collapsed ; natural size.

Fig. 2. Tuber with a developing scape ; note remains of rhizome at base of tuber ; natural size.

Fig. 3. A small tuber, apex to left, viewed from above ; natural size.

Fig. 4. A rhizome with developing tubers ; the tubers which appear double are linked by a short rhizome, × 2.

Fig. 5. ditto; in both 4 and 5, the attachment of the tubers is not clear, because of the development of hairs at the nodes ; × 2.

NOTES

Characeae and mosquito larvae. When *Nitella oligosperma* Braun and *Nitella sp. aff. batrachosperma* were being grown in the laboratory at Peradeniya, mosquito larvae appeared in large numbers in the dishes. They were all Culicines, probably *Culex fatigans* Wied., which was then frequent in the laboratory. These two species of Nitella were not injurious to Culicine larvae. It may also be noted that *Anopheles spp.* occurred in the ditch from which the Nitellas were collected.——T. Petch.

Wolffia microscopica (Griff.) Kurz. This species occurred in March 1920 at Anuradhapura in a pond near the Post Office. It was not in flower. The writer being then engaged on administrative duties, it was not possible to enquire further into the matter, and he was absent from Ceylon on leave during the early part of 1921. In March 1922, a search was made for the plant, but only *Lemna paucicostata* was found in the locality cited. *Wolffia arrhiza* was abundant in the " well " within the buildings attached to the Ruanweli Dagoba.——T. Petch.

Phreatia elegans Lindl. This species was collected in Ceylon by Macrae (1827-1830), but no locality is given on the single specimen in the Peradeniya herbarium. It had not been collected again in Ceylon until December 1924, when Dr. S. B. Stedman found it in the jungle at Meeriacotta, Maskeliya. In the same locality, Dr. Stedman has obtained *Sarcochilus viridiflorus* HK. f., a rare species orginally collected by Gardner.——T. Petch.

Cirrhopetalum Trimeni Hook. f. As stated by Hooker in the Flora of Ceylon (IV, p. 158), the description of this species is one which Dr. Trimen left in manuscript, there being no specimen in the Peradeniya herbarium nor any figure amongst the drawings. It is probable that the description was a preliminary one drawn up by Trimen on a collecting

tour. What is taken to be this species was collected by Smith at Hakgala in 1906, and has recently been sent in by Mr. A. N. Paine from the Maturatta district. All these specimens agree with Trimen's description, except in one particular, viz. that the lateral sepals are three-veined, not one-veined. The veins are frequently rather close together, and the fact that there are three might then be overlooked. The margins of the dorsal sepal, and the petals, when viewed under a high magnification, are dentate, and the obtuse tip of the petal, which is furnished with a tooth at the apex of the single vein, frequently has two other teeth, one on each side. The dorsal sepal is three-veined.——T.Petch.

Bangala. In Hermann's Musaeum Zeylanicum, p. 51, the Sinhalese name Banghala is recorded, with the note, " Radix transfertur ex Malacca in Zeylonam," and in Hort. Acad. Lugd. Bat., p. 211, Hermann wrote that Bangala Indorum had the same fructification as Curcuma, Cardamomum, etc. Thunberg, Travels, IV., p. 147, stated that Bangle was the Malay name of *Amomum Zingiber* and *Amomum Zerumbet*. Rumphius, however, in Herbarium Amboinense, gave Bangle as the Malay name of *Galanga malaccensis* Rumph. The latter plant has hitherto been taken to be *Alpinia malaccensis* Rosc. of Roxburgh, but Ridley says that it is different and has described it as *Alpinia nobilis* Ridl. If, as Hermann stated, the Ceylon plant was brought from Malacca, it should be *Alpinia nobilis* Ridl. It would be of interest to determine the identity of the plant which passes for *Alpinia malaccensis* Rosc. in Ceylon.——T. Petch.

Cuscuta Chinensis Lam. This species was recorded by Trimen, in Flora of Ceylon, as very rare, only found about Colombo. During the last ten years, it has spread remarkably in the district between Colombo and Kandy, and is a conspicuous feature on the road sides. It is especially noticeable that it is at first confined to the road sides, and this suggests that it is in some way distributed by animals, possibly cattle. It is also remarkable that, although it has been common for the last nine years along the river side road leading to the Experiment Station, Peradeniya, it has only once appeared in the Botanic Gardens on the opposite side of the river, in spite of the fact that the banks on the two sides are covered with similar vegetation. Moreover, its occurrence on the bank on the Botanic Gardens side of the river was at the ferry to the Experiment Station,—a ferry which carries only people and dogs. This would support the view that it is conveyed by animals (including man), while its failure to cross the river at any other point is evidence that it is not spread by birds.——T. Petch.

Turmeric. In Ann. Perad., VII., pp. 160-164, it was recorded that the Ceylon Turmeric had pale green bracts, often with a few longitudinal white stripes or bordered with white, while some of the coma bracts were wholly white. In these respects, and in the colour and structure of the flower, the Ceylon plant was *Curcuma domestica* Val. It was also noted that in some specimens, the coma bracts, especially the uppermost, bore very minute purple red spots, only distinguishable as spots with the aid of a lens, on the upper part of the bract, and chiefly towards the margin, so that the uppermost coma bracts were slightly tinged with purple at the edges. Mention was also made of a specimen, grown as Turmeric in a native garden, in which the bracts were white, with purple or reddish purple tips, the colour becoming more pronounced on the uppermost bracts. In this latter specimen the flowers were immature, and their structure could not be ascertained. This plant has been kept under cultivation, and on subsequent flowering it has been determined that it is *Curcuma domestica* Val. The coma bracts of the latter may therefore be either green and white, or white, or white with purple or reddish purple tips. Hermann stated that the bracts of his *Flos Curcumae* were pale green at first, afterwards " ex flavo rubentia vel ex pallido flava."——T. Petch.

Weeds. *Eleutheranthera ruderalis* (Sw.) Schultz appeared at Henaratgoda in November 1920, in beds of *Chenopodium anthelminticum* grown from American seed. *Richardsonia pilosa* H. B. K. was sent in from a mid-country estate in April 1924, as a weed which was becoming established, with the information that it was called Buta Suri by the Tamils, and that pigs burrowed extensively for the root; there is a specimen in the Peradeniya Herbarium, from the Botanic Gardens, Peradeniya in 1899. The European nettle, *Urtica dioica* Linn., is established (February, 1923), at Nuwara Eliya.——T. Petch.

Vernacular names. *Marsilea quadrifolia* L. has been sent in from the Southern Province under the name Peti-pala. *Litsea fuscata* Thw. was received from the Haputale district as Kudukurundu, which is the Sinhalese name of *Cinnamomum litseaefolium* Thw. *Eryngium foetidum* Linn. was sent in under the Sinhalese name Andu. Mr. F. Lewis records the Sinhalese name Berendiya for *Tournefortia argentea* L. f. in the Tangalle district, and Gal-nawa for *Sterculia Thwaitesii* Mast. in both the North Western and the Southern Provinces. Mal-weralu has been recorded for *Ela ocarpus montanus* Thw. in the Haputale district; Weralu is a generic name for Elaeocarpus. *Albizzia amara* Boiv. was given the Sinhalese name Iha in the Haragam district. A narrow-leaved

form of *Alangium Lamarckii* Thwaites was sent in as a specific for hydrophobia under the Sinhalese name Ruk-anguna. *Indigofera galegoides* DC. was received from the Matale district under the Sinhalese name Weliweriya ; this may be a corruption of Wal-awari, the name applied to *Indigofera trita* L.f. *Hydnocarpus venenata* Gaertn. was sent in from the Galle district under the Sinhalese name Makitiya. A report having been received that the young fronds of the "Australian fern" were used as food, specimens were obtained and were found to be *Nephrolepsis exaltata* (L.) Schott.—T. Petch.

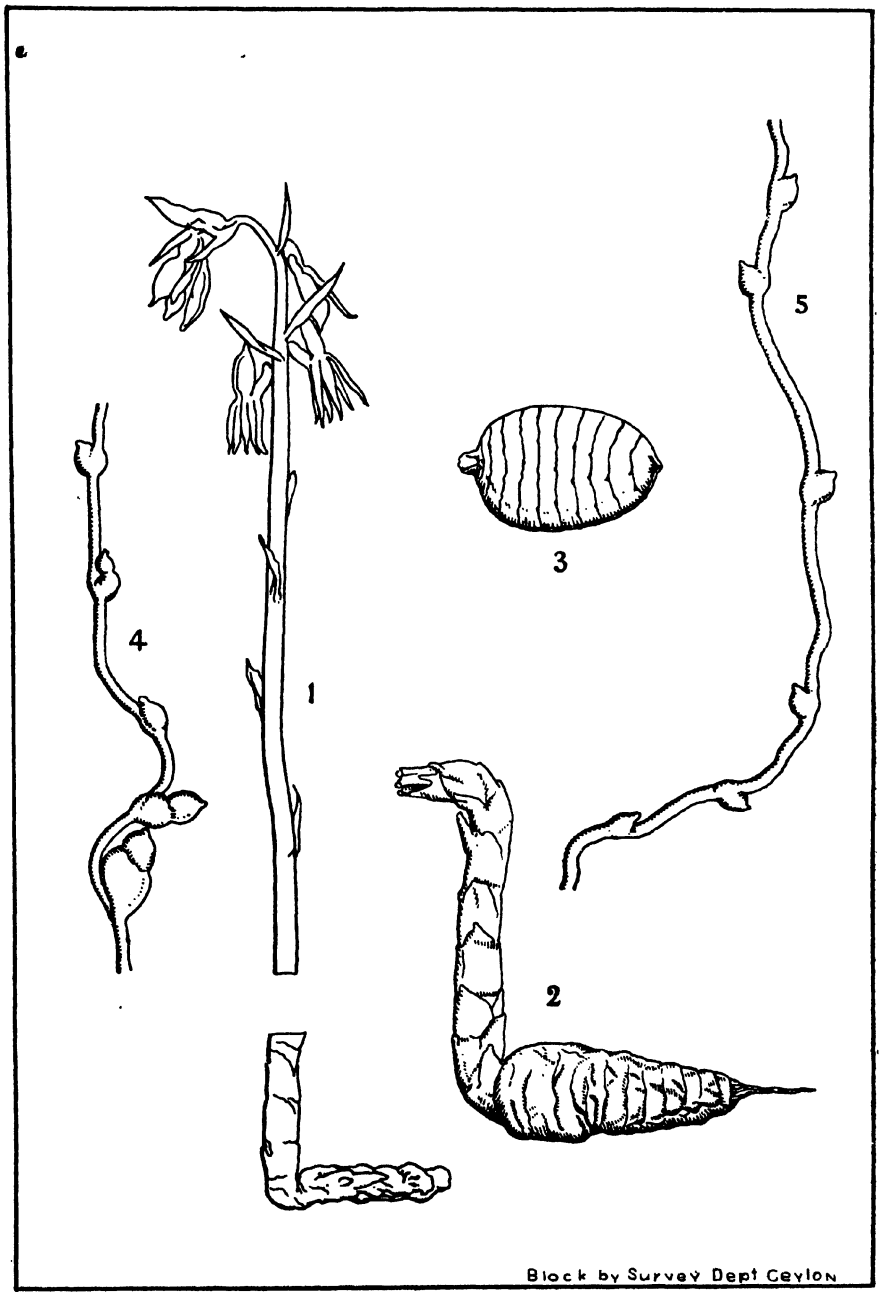
Coleus Rehneltianus A. Berger. This plant was collected by Rehnelt at Anuradhapura about 1913, and seeds were subsequently distributed. In 1921, it was in cultivation at Kew, and was recognised as having been grown for many years in the Royal Botanic Gardens, Peradeniya. It has since been determined at Kew as *Coleus pumilus* Blanco. The date of its introduction to Peradeniya is not known. As the Hotel grounds at Anuradhapura were formerly a branch Botanic Garden, there seemed a possibility that the plant had been originally sent from Peradeniya and had survived the abandonment of the garden or had persisted as an escape. It is not, however, growing in the grounds now, and it is improbable that it could ever have survived there untended. It is more likely that the plant was collected from pots on the hotel verandah.—T. Petch.

Vanda Roxburghii Br. A "pink" form of this species has been known for many years,and is to be found especially in the neighbourhood of Madu Road. Mr. G. B. Foote collected another colour variety at Damboul in 1924, in which the flower is yellow. The three known colour forms of this species in Ceylon are as follows :—

Normal form. Sepals and petals greenish grey with a very narrow paler margin, tesselated with slaty grey lines ; mid-lobe of lip bright blue ; column, and internal face of lateral lobes of lip bluish white, sprinkled with minute blue spots.

Pink form. Sepals and petals pinkish brown, tesselated with darker brown lines ; lip red-purple ; column white, with small purple spots on the back.

Yellow form. Sepals and petals yellow to greenish yellow, not tesselated except structurally when the flower is old ; lip purplish rose, somewhat brownish above, the two lobes of the lip rather larger and more divergent than in the normal form ; column and lateral lobes of the lip pale yellow, not spotted ; two small triangular areas, minutely spotted brown, at the base of the lip, just below its junction with the column.—T. Petch.



Epipogon nutans

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ERRATA.

(To face p. 1, Ceylon Journal of Science, Sect. A, Vol. X.)

P. 9, l. 4.—For "3 endemics" read "2 endemics."

P. 13, l. 3.– For "these" read "here." l. 4 delete "here"

P. 49.—Opposite *Acrotrema Gardneri* move x from 3,000 ft. to 1,000 ft. column.

Opposite *Uvaria macropoda* insert x in Eastern 2,000 ft.

Opposite *Unona elegans* delete x from Eastern 2,000 ft.

P. 51.—Opposite *Xylopia parviflora* move x from Eastern 4,000 ft. to Eastern 1,000 ft.

Opposite *Xylopia nigricans* move x from Eastern 3,000 ft. to Eastern 1,000 ft.

Opposite *Goniothalamus Hookeri* move x one column left.

P. 53.—Opposite *Stellaria drymarioides* move x from 5,000 ft. to 4,000 ft. column.

P. 55.—Opposite *Dipterocarpus zeylanicus* and *Doona cordifolia* move x's from Eastern 4,000 ft. to Eastern 3,000 ft.

P. 57.—Opposite *Stemonoporus rigidus* insert x in Western 2,000 ft. column.

P. 59.—Opposite *Elaeocarpus obovatus, montanus, zeylanicus* and *glandulifera*, move x's one column left.

P. 69.—Opposite *Serpicula zeylanica* delete x's and insert Western 6,000 and 7,000 ft. and Eastern 6,000 ft.

Opposite *Eugenia cylindrica* insert x in Western 2,000 ft

P. 71.—Opposite *Eugenia phillyraeoides, rotundata, Mabaeoides*, and *aprica*, move x's one column right.

P. 77.—Opposite *Heptapleurum emarginatum*, move x's one column left.

P. 79.—Opposite *Hedyotis nodulosa, cinereo-viridis, rhinophylla, Lessertiana, quinquenervia, Gardneri, Lawsoniae, inamoena, cyanescens*, and *Leucocodon reticulatum*, move x's one column right.

Opposite *Anotis nummulariformis* insert x in Eastern 5,000 ft.

Opposite *Urophyllum zeylanicum*, move x's one column left.

P. 89.—Opposite *Symplocos cordifolia* move final x one column left.

P. 95.—Opposite *Christisonia albida* insert x in Western 6,000 ft.

Opposite *Chirita zeylanica* insert x in Eastern 3,000 ft.

P. 99.—Opposite *Justicia Hookeriana* delete x in 3,000 ft. column.

P. 101.—Opposite *Peperomia pseudo-rhombia* move x from 5,000 to 4,000 ft Eastern

P. 107.—Opposite *Cleistanthus pallidus*, delete x in Western 4,000 ft.

Opposite *Phyllanthus oreophyllus, hakgalensis*, and *affinis*, move x's one column left

P. 109.—Opposite *Hemicyclia lanceolata*, insert x in Western 1,000 ft.

P. 113.—Opposite *Cirrhopetalum Macraei*, insert x in Eastern 3,000 ft.

P. 117.—Opposite *Podochilus saxatilis*, insert x in Eastern 2,000 ft.

P. 121.—Opposite *Cyanotis zeylanica*, insert x's in Western 4,000 ft. and 6,000 ft.

Opposite *Areca concinna*, remove ½ from 1,000 to fruit column and substitute x.

P. 125.—Opposite *Arisaema filicandatum*, remove x one column right.

P. 127.—Opposite *Isachne multiflora* insert x in Eastern 5,000 ft.

The Altitudinal Distribution of the Ceylon Endemic Flora

BY

F. Lewis, F.L.S.

It is proposed in this paper to give a brief sketch of our endemic flora only, exclusive of cryptogams with an attempt to place the individuals in the position of their altitudinal distribution.

I have been guided so far in this effort by the data I have obtained from *Trimen's Flora of Ceylon*, and I follow his classification, as well as his nomenclature. In some instances I have assigned altitudinal location from my own personal observations, but these I have not specially recorded, as I think it would be superfluous to do so.

I find, at the very outset of the work, that much more data are required with regard to the flora of our eastern section than that of the west, so that I feel conscious that the tables at the end of this paper are far from complete or satisfactory, as I am not aware of the existence of an exhaustive botanical exploration of certain ranges of mountains, by which can be determined the flora of those localities, for purposes of comparison with the flora of the westward slopes. In saying this, I refer in particular to the great mass of hills extending from the Rangalla District in an easterly direction to, say, the Mahaweliganga river. I have personally explored the summit of the "Knuckles" Peak (6,112 ft.), and the country at the foot of this range on its eastern base, but the intervening region is unknown to me, and is, I believe, incompletely botanically explored.

In the tables appended, I have made a rough division into two parts: westward and eastward, taking as my division a line approximately north and south, from the Trigonometrical Station on Pidurutalagala (8,292 ft.)—the highest point in Ceylon.

Obviously, such a north and south line is practically defective, as it would cross valleys that have equally eastern and western aspects, that would clearly produce confusing results if strictly followed; hence it must be understood that my western and eastern limits are separated more or less roughly, so as to give, as far as possible, a distinction between the general plant distribution on both sides, or aspects, of the Island.

Owing to the imperfection of the data at my disposal, I considered that the totals arrived at in my tables can only be accepted with reserve, so that all attempts at comparison between the number of plants recorded from the west of the Island, as compared with those on the east, at any given elevation, may be modified at any time, upon more minute exploration being effected. These figures, therefore, must be regarded as tentative. It is hoped that a more complete examination will, in time, be made, in order to supply the deficiencies that now strike one as obvious, more especially as there is no reason to assume that so many forms recorded in the west, *cannot* occur in the east.

In the course of my analysis under orchids, certain special reference might be made to the striking absence of particular forms, but it is not necessary in a brief introduction to my subject, to dwell more particularly on these points, out of their regular sequence.

The obvious variation of rainfall in many parts of Ceylon naturally affects the vegetation; and perhaps, in proportion to its area, there are few places in the world where such wide changes of rainfall occur as in this Island.

It is possible, in a single day, to leave a spot in the morning where the annual rainfall averages 40 inches, and arrive at another, in the same day, where 350 inches of rain, or more, fall in a year. These conditions are important.

It may also be observed, that while this great variation of rainfall occurs, yet it is more on the westward half than on the eastward; and it naturally follows that the proportion of perennial streams are more numerous in the west than in the east. This condition sets up a larger soil denudation accordingly, but, on the other hand, the diminished rainfall increases the soil desiccation, due to sun-heat, and thereby produces conditions of, and on, vegetation, that cannot occur where the moisture is greater or more uniform.

Much importance, therefore, must be attached to rainfall distribution; in fact it may with certainty be said, that unless the moisture reaches a certain amount yearly, that certain forms will be found to occur. A typical example of this is to be found in *Schizostigma hirsutum*.

It also follows that a more evenly distributed rainfall reacts upon human operations, so that large areas of country that were once forest are now in permanent cultivation, whereas, in the localities where water is scarce, very much of the land that has been brought under a form of cultivation has been subjected to periods of abandonment, when once more the land reverted to a secondary growth, in which an entirely different struggle for existence followed the destruction of the primeval growth.

How far these operations dislocated then existing forms, it is impossible to say, but it is reasonable to assume that they did do so.

On the other hand, by cutting down much of the natural vegetation, the opportunity *may* have been given to certain struggling forms to find more space wherein to survive. But this, again must, in the nature of things, be speculation.

Without attempting to find the cause of our *Patana* lands, we are faced with the fact that they play an important part in the distribution of our flora. It is striking, that while these Patana lands absorb a very large extent of our mountain area (estimated at 1,000,000 acres), they do not produce a large number of endemic species of grasses, yet the grasses form our largest order.

The evil and destructive practice of burning these Patana lands may have much to do with the loss of many forms of plants, not confined to the *Gramineae* alone, but that is hardly sufficient to explain why so few species under this great order are endemic, as compared with other orders. It can hardly be contested that their seed dispersal is more difficult, or apparently is not.

The *Talawa* lands, or as they may be crudely described as Jungly Patanas, are also curiously deficient in endemic forms in proportion to their extent, but, on the other hand, Talawas are not common in regions of considerable rainfall. They may be said to belong to the dry region, extending from a little above sea-level to 1,200 feet, after which they assume more of the typical Patana form, and less of the " Park " character ; while the true Patana form of land is more common at high altitudes, the Horton Plains, for example.

In his masterly paper on the "Botany of the Ceylon Patanas," Pearson[2] supplies an important list of Patana plants, but it is striking that it does not record one single endemic genus, though it enumerates 43 endemic species.

This is the more remarkable when one notices the large number of endemic genera set out in the tables of distribution, as it is evident that the altitudinal range of our Patana lands fully comprehends those altitudes in which endemic genera can exist. The conditions of light are, however, very much different, to which must be added the adverse conditions of a matted surface (generally speaking), as contrasted with a free surface, or one shaded by other growth.

In an abstract given by Pearson of the total flora of the Patana lands, it is significant that, below 4,500 feet altitude, the *Gramineae* form the larger percentage, while above that level the *Compositae* are in excess. Further, it may be observed, that below 4,500 feet the *Leguminosae* are more numerous per cent., than at the higher altitude, yet

of leguminous species we have only a gross total of 12 endemics out of 64 genera and 207 species.

The action of wind is of great importance in considering the possibilities of dispersal of plants, and the difficulties plants have to accommodate themselves to conditions when wind is severe. Though Ceylon may not be regarded as a country where the winds are of exceptional violence, yet their force is sufficiently severe in many parts of the Island to affect the vegetation in a very marked manner. This is particularly so in those places above 4,000 feet altitude, and again on the coast on the south and west, where the forest is materially stunted by the wind; but where there is the combination of high wind and low rainfall, the effect on the vegetation is most marked.

A careful exploration of the forests north of the railway from Mannar to Medawachchiya, and south of the same line to the valley of the Kala Oya, is very convincing with regard to the effect on vegetation of wind ; but within this area there are other conditions, which will receive consideration in their place.

Round Madugoda, where there is a combined condition of high wind in the south-west, and a mid-altitude, there are peculiar characteristics of growth in Patana areas, such as an abundance of Eugenias. The same condition applies to the Patana lands east of Belihuloya, from 2,000 feet to 4,000 feet altitude, where once more *Eugenia* and *Careya* are characteristic.

Where a high altitude is much affected by the monsoon, both with respect to rainfall as well as wind, it is noticeable that stems of trees become much shorter, crowns closer and much frayed, and leaves more coriaceous above. For example, at 5,000 feet, on the Gongalla range, I have found *Wormia triquetra* with leaves 3 inches and less in length, while at 1,000 feet they are often as much as 10 inches long, with poorer soil to grow in.

Correspondingly, at the summit of Pettiagalla (4,687 feet), where the exposed condition of the mountain to the S. W. monsoon is most extreme, the vegetation is only a few feet high, and difficult to walk through without tearing one's clothes to pieces. On the top of Detanagalla, where the wind is serious, and the humidity is considerable, *Garcinia echinocarpa* appears more like a bush than a tree.

On the summit of the "Knuckles" (6,112 feet) facing eastward, the growth is dense, almost matted, so that light conditions for plants growing under this vegetation are most unfavourable.

The influence of Chena cultivation is perhaps one of the greatest importance in the matter of destruction of species. It must, however,

be divided into two very distinct divisions, viz., *Dry Zone* Chenas, and *Wet Zone.*

As already known, the operation of "Chena Cultivation" consists of cutting down the forest or jungle before the rains, burning, and growing in a most primitive manner such crops as the people require for food. These are mostly grain crops. Enormous quantities of plants, large and small, are destroyed by this wasteful form of "culture ; " the land is in no way conserved against denudation, and after the crop is taken it is simply abandoned, till such time as the so-called "cultivator" is pleased to cut down the secondary growth, to repeat the " cultivation " again. No form of agriculture could be more wasteful than this, or less excusable, but as this paper is not devoted to administrative questions, these deplorable methods need not further be discussed. In the wet zone, such for example as the Kukulu Korale, where chena cultivation has impoverished both land and man to a terrible extent, much of the secondary growth is marked by dense masses of *Gleichenia linearis*, with patches of *Hedyotis fruticosa*, *Wendlandia Notoniana*, *Aporosa latifolia*, and frequently *Phoenix.*

On the stream sides, in swamps, and in places where the chena fires have not done their worst, a little is left of the natural vegetation, the wet ground in particular, in which in the case of marshes, examples of the *Eriocaulonaceae*, and *Cyperaceae* are very abundant. *Nepenthes distillatoria*, Exacums, Torenias, and Burmannias, are also very characteristic of moist patches of soil in the particular locality mentioned. In other wet-zone chena lands of the western slopes at low altitudes, *Ochlandra stridula* practically excludes other vegetation, growing as it does in large and dense masses.

In the dry-zone chenas, the secondary growth is naturally very much retarded by the drying of the soil, though, broadly speaking, the soil is much richer, and owing to the greater flatness of the ground, there is not so much soil denudation, while it has the additional advantages of holding up silt from higher levels. Yet, with all these advantages, the secondary growth is excessively poor in species, and poor in size of growth. Masses of thorny bush practically describes the succeeding growth in the dry country. In many places an abundance of *Malvaceae* might be regarded as almost typical, while in others there may be a preponderating amount of *Carissa* an uncomfortable abundance of *Randia* or *Flueggea*; but nowhere in these desolated areas do we find a restoration of species to their normal numbers, even though individuals will be found in great abundance.

It can hardly be said that the secondary growth in these chena lands succeeds in producing full grown trees, even after they have es-

caped a second or third rotation of cultivation ; thus it may be safely asserted that the distinction between primeval forest (*Mukalana*) and the very best secondary growth is always marked and pronounced. We may then expect to find the inaccessible, or practically inaccessible, forests to be richest in species, thus materially adding to the complexity of the problem of distribution.

Another aspect of the situation is the introduction of species by man, these having in the course of time established themselves, and entered into competition with the natural flora. No better examples could be found than in *Ageratum conyzoides*, *Lantana*, and the still more recent of introduction, *Mikania*, not to mention many others that are well-known but less apparent. In the case of *Mikania scandens*, we have a pestilential weed, that by completely growing over forest trees has, in many parts of the wet-zone, completely destroyed the natural vegetation within a few years. In the valley of the Weganga, *Mikania* was unknown in 1890 : to-day it is to be found covering large areas of ground and stamping out the native flora.

Ageratum conyzoides is to-day an abundant weed, even in the dry-zone, while *Lantana*, which was introduced about 100 years ago, is now so completely in possession, as to justify the expression, " Lantana land," being used in many of our districts.

This successful establishing of a foreign species has undoubtedly been the result of the stranger not having the same enemies to contend against in the land of its accidental adoption, as it had in its natural home. It therefore succeeded enormously, when it was relieved of this competition, with the result that it established itself at the expense of its new and unprepared neighbours. Such successes as these must react on indigenous and non-idigenous flora equally, and it can only be a matter of time for the new-comer to find its own conditions of life restricted, but that interval may involve the extermination of many endemics that otherwise might have become established.

How long it may take to exterminate any one particular species, endemic or otherwise, is probably unknown, but it certainly can be demonstrated that such has happened within a comparatively short time, notwithstanding favourable soil, rainfall, and light variations. I can, within my own recollection, instance an example of a land that was cleared and abandoned, becoming, at first, a sort of pasture for cattle, who fed freely on fruits of *Psidium Guajava*. The cattle, in their droppings, deposited the seeds, which grew with such abundance that when I revisited this spot a few years ago, it practically formed a sheet of guava trees. Yet this plant is a native of Tropical America.

A very remarkable *Calophyllum* is to be found growing in wild profusion below a cave near the summit of Degalhella, on the confines of the Eastern Province. The cave was, in ancient times, in occupation by priests. The fruit of this species of *Calopyllum* is rich in a green oil that is a specific for itch, which is a common disease in the dry country, and it is alleged that the priests employed this particular oil as a remedy, which accounted for its introduction.

In the same manner *Mesua ferrea* is found in regular forests of that plant, in several places in the Island. On the summit of " Westminster Abbey" ("Govinda Hella") that can only be reached by placing ladders into various crevices, the common pineapple grows on one particular portion of the rock in profuse abundance. It is only a short distance from the ruins of a palace that once stood there, among the remnants of which I found *Notonia grandiflora*, that could hardly have got there by accident.

While admitting the difficulty of accounting for the distribution at certain altitudes of certain specific endemics, the evidence I think is strong, that the action of man has played an unconscious, but important, part in separating forms that otherwise would appear to be more common, and by this process of separating or isolating patches of natural jungle or forest, a new form of inter-competition has been set up, owing to the restriction of the areas involved.

The above brief sketch is, at best, only an outline that is deficient in details. The tables that follow show against each endemic species its distribution altitudinally, while a brief analysis is also given bearing more directly on the orders involved, and their method of growth, from the dispersal stand-point.

Without more complete knowledge of the individual means of transmission, it is but speculative to account for the distribution beyond possible means, or obviously possible ones, and therefore I feel it would be idle to attempt to lay down any law on the subject. Equally, as our data leaves much room for amplification, I see no advantage in showing any particular ratio of proportion between our total flora and that at any particular altitude, or where a family is specially well represented.

The order *Ranunculaceae* is represented in Ceylon by 5 genera, and 7 species, of which one is endemic. The seeds are apparently not specially sought for by any particular animals. Our one endemic is found in marshy land at high altitudes, in Patana lands. The seed is possibly water-carried.

The *Dilleniaceae* are represented in Ceylon by 6 genera (1 confined to the Island), 15 species, varieties excluded, of which 12 are endemic. On reference to the table illustrating altitudinal distribution, it will be

observed that the genus *Acrotrema* is richest in endemics, and that these are best represented at 2,000 feet on our westward slopes. I think it is probable that some occur on the eastern slopes, but I have no data.

Under *A. uniflorum*, Trimen records no less than nine varieties, which I have not recorded, but the number of endemic species alone is striking. The fruits do not appear to be specially attractive, or to have special means of dispersal. They—the endemic species as a whole—usually select steep, shady, mossy banks for their growth, *lyratum* alone preferring large damp rocks to grow upon. It appears possible that caterpillars may convey the seed, internally or entangled on their hairy bodies. Where they occur, the plants of this genus might be said to be gregarious.

In *Schumacheria* (the genus confined to Ceylon) we find the same gregarious habit in the two low wet-country species, *S. castanaefolia*. and *S. angustifolia*, while the hill species, *S. alnifolia*, is almost solitary. The seed dispersal may be by water, and spread naturally from centres.

Wormia triquetra has a fleshy fruit, and is probably animal-carried. Its absence in the east is remarkable in a plant with such a range.

Dillenia retusa. Fruits, animal-carried. This plant is also economic, and may be artificially spread.

The large order *Anonaceae* is represented in Ceylon by 13 genera, and 39 species, of which no less than 21 are endemic. Of these endemics, only a very few are found in the hills, and comparatively only a limited number are in the eastern section of the country. The fruits may, without elaboration, be classed as fleshy, while most of them are distinctively attractively coloured, so that animal-transportation is most likely.

Our specially hill form, *Bocagea coriacea*, is not attractively fruited, but as it is abundant in steep land, its dispersal by gravitation is possible, as its presence on *flat* land is not so great as on steep. The scarcity of *Alphonsea sclerocarpa*, and its restriction to the eastern aspect of the country, is significant. Its fruits are ovoid and hard.

It will be observed that though the well-represented order *Menispermaceae*, with it's 10 genera, has advantages in being able to climb over other plants, yet it supplies no endemic species, while two other climbing orders, or practically climbing orders, the *Asclepiadaceae* and *Convolvulaceae* produce 7 and 3 endemic species, in 4 and 3 genera respectively. As all these three orders have this advantage of growing over the tops of their supporters, and the *Menispermaceae* in particular have attractive fruits, it is the more noticeable that Ceylon has no endemic example.

It is also striking that the *Capparideae*, with their abundant representation in genera and species, have no endemic forms here.

The *Violaceae* are comparatively poorly represented. We have only 3 genera, and 8 species, yet we have 3 endemics, with dry fruits, belonging to a low altitude.

The *Bixaceae* have 6 genera and 11 species, of which 7 are endemic. One of the genera is monotypic. The table shows that order is fairly confined to below 3,000 feet, with one exception, while the fruits are all beast-attractive. *Hydnocarpus venenata* is water-carried, and abundant in both aspects.

The *Pittosporaceae* is here represented only by a single genus and 2 species, one of which is endemic, and appears both in the eastern and western sections. Its red pulpy testa probably makes it bird-carried.

The *Polygalaceae* are made up of 3 genera, containing 11 species, of which in Ceylon, 2 are endemic and confined to the lower altitudes of the western aspect. The fruits are not attractive, but are possibly water-carried.

The *Caryophyllaceae* are well represented in Ceylon, there being 5 genera and 6 species, of which *Stellaria drymarioides* is peculiar to the country, but has only once been found here. This may be found to be an introduction. The order does not present any attractions to animals to secure their help in dispersal of seed.

The important order *Guttiferae*, composed of trees, is represented by 4 genera and 19 species, of which there are 11 endemics, each genus contributing. Most of the endemics belong to the low-country, the outstanding montane forms being *Garcinia echinocarpa*, and *Calophyllum Walkeri*. The fruits of both *Garcinia* and *Calophyllum* are animal-attractive, as well as economic, so that their distribution is simple. *Mesua Thwaitesii* is water-loving, but it is particularly noticeable that the distribution of this particular endemic is confined to stream-sides in places of high rainfall. It might be looked for in streams below the "Nitre cave" district, as so far it appears only to be recorded from the western half of Ceylon. *Kayea stylosa* I have found in very wet ground in the Pasdun Korale. The seeds are doubtless water-carried.

The *Ternstroemiaceae* in Ceylon form 4 genera, and 7 species, of which 4 are endemic, and all confined to the higher altitudes, one of which, *Gordonia speciosa*, has been but once recorded. The fruits do not appear to be animal-attractive. *Terntroemia emarginata* is water-loving, while the seeds of *Gordonia* may be, to some extent, wind-carried. *Adinandra lasiopetala* has fleshy fruit, that I suspect is eaten by the hill myna, much as I have seen this bird eating the fruits of *Myristica laurifolia*.

The large order of *Dipterocarpaceae* is very well represented in Ceylon, and, from the point of view of trees, is perhaps our most valuable family. It consists of 10 genera, and 48 species, of which no less than 47 are endemic. Of the genera, *Doona*, *Stemonoporus* and *Monoporandra* are peculiar to the Island.

More than a passing notice is deserved by this great family of trees, that present complex questions as to their local distribution. Most of the members have winged fruits, and many of them have a distinctly gregarious habit, while there are apparently none at our highest altitudes. Moreover, the order, as a whole, appears to be confined to the western section of the country; the outstanding eastern form being *Vatica obscura*. *Dipterocarpus* is a conspicuously winged genus, and fruits are often carried by the wind to considerable distances. They are, however, much subject to insect attack, so that many are destroyed in this manner. All are gregarious within certain limits. *D. zeylanicus* occurs as one of the few Uvan Dipterocarps, but rapidly disappears after passing a little way beyond Park Estate, Lunugalla. *D. scabridus* I have obtained in one small cluster of trees in the Pasdun Korale, and it is recorded from Ratnapura.

Shorea is apparently a western-Ceylon genus. It's fruits are wind-carried, but the distribution is more or less confined to isolated patches, where numerous individuals cluster. *S. stipularis* appears to be patchily common in the wet Kukulu Korale, where I have found it in rocky ground on hill tops. *S. reticulata* I have doubtfully included. The same may be said of *S. Dyerii*, which, I *think*, occurs at Udugama.

Doona is a distinctly western form, of which one, *D. Gardneri* belongs to the hills. All are strongly winged, and all are gregarious, within limits. I have found, especially with *D. Gardneri*, that seedlings are frequently to be seen in masses, so that it would be impossible for more than a very limited number ever to reach maturity, so that the mortality must be exceedingly high.

Coupled with this circumstance, is the further fact, that during the monsoon numbers of immature fruits are torn off by the wind and scattered, from which it may be assumed that of the total volume of fruits produced in a year by a single tree possibly not one per cent. ever reach maturity. *D. zeylanica* appears to share the same disability as the last named. *D. congestiflora* is distinctly gregarious, and in places quite common, but it is certainly only so in isolated masses. *D. macrophylla* is another example of isolated gregariousness. I have found it in abundant masses in the Kukulu Korale, and again at Hewissa, and at Udugama, all places of high rainfall. Monkeys certainly eat the

fruits of *D. macrophylla* and *D. cordifolia*, but I think that transportation by their agency is exceedingly improbable.

Hopea affords one very large tree in *H. discolor*, which is locally gregarious in parts of Sabaragamuwa, and bears strong wings. *H. jucunda* is decidedly a water-loving plant, and probably the fruits are water-carried. The little variety, *modesta*, is in certain places distinctly gregarious, as I have found it so both in the Sabaragamuwa Province, and in the Pasdun Korale, but always in places of high rainfall. *H. cordifolia*, on the other hand, I have found close to streams in the south of Uva, and in the neighbourhood of the Wallawey river close to Uggalkaltota. It flowers at very distant intervals of time. The fruits are winged, but I think are water-carried.

Sunaptea scabriuscula is distinctly a rare species. It is winged, but I have nowhere found it other than confined to small groups of trees.

Vatica obscura I have found in isolated gregarious masses generally near streams in the south-eastern part of Ceylon. The farthest western limit to which I have traced it was in a dry stream on the south of "Westminster Abbey." On the other hand, Tumpalancholai takes its name from this plant, which in Tamil is "Tumpali"—as obvious corruption of the Sinhalese word Dumalla, meaning resin, from the highly resinous nature of the plant.

Balanocarpus, an Indian genus, is in Ceylon very restricted. Our only species, *B. zeylanicus*, if it is to be included, appears to be confined to the top of the isolated Doluwakanda mountain, where I found it growing gregariously and abundant.

It may be worth considering, that on the top of this mountain there are the remains of an old palace and a tank, so that this strangely isolated plant may have been introduced. It's fruits do not suggest animal-transportation.

Vateria acuminata is distinctly water-loving, and has large fruits easily carried by water. The fruits are moreover eaten. I have failed to find it in the eastern half of the Island, but I suspect that it has been overlooked.

The large genus *Stemonoporus* with its 15 endemic species which are all spherical fruited, and have no special attractive features for animal-transportation. Of these, *S. Wightii* is water-loving, and the fruits are, as I have found, water-carried. On the other hand, the distribution is restricted. *S. Gardneri* is a hill species, found in steep land, where it is sub-gregarious. *S. acuminatus* is one of our rare forms, and apparently riverine. *S. affinis* is, as far as I have found it, sub-gregarious, and devoted to very steep land at high levels. The fruit I have

frequently found at long distances from the parent trees, having rolled down. *S. caniculatus* has likewise globular fruits, but is not found in the same local abundance as the last. *S. petiolaris* I have found in the Rakwana hills, west of Gongalla, in apparently very wet forest. It is confined, as far as I know, to gregarious patches.

Passing to those of this genus with which I am more familiar, I may perhaps be excused for dealing in some detail with two discovered by myself. Of these, *S. Lewisianus* so far has been found only in Sabaragamuwa, and in each case on the very summit of rocky hill tops, and restricted to a very small area. Some of the trees I found were of immense size. The fruits are very small, very much grub-eaten, and distinctly unattractive. The plants grew gregariously, and suddenly at a comparatively short distance appeared to be totally absent. The rainfall of the two places where I found these handsome trees must have been close on 200 inches per annum, and the place seriously wind-blown. The two places were wide apart, the first being about 2 miles from Pelmadulla and above Bambarabotuwa, and the second in Eratna, on the edge of the Peak Wilderness.

S. revolutus I found in a precipitous mass of rocky land overlooking Deepdene Estate, in the Kukulu Korale. Here the plants were subgregarious, but confined to a very small area. The fruits are globular, but not abundant on any of the parent trees. Rainfall, high.

Monoporandra cordifolia occurs in the wet forests of the Adam's Peak range. I have found it in very steep lands only, and have traced it eastward of Meriakotta Kanda in the forests overlooking Waleboda, but nowhere in large numbers. The fruits are globular, but not eaten by any animals as far as I am aware.

Ancistrocladus Vahlii is a low-level form, capable of climbing to a limited extent, and possess winged fruits. It is, however, fond of moist ground. Apparently it is a low-level western form, and certainly not rare.

The order, as a whole, presents many difficulties in the way of explaining its erratic local distribution. It appears to be distinctly Malayan, extending as it does to New Guinea, from which country, according to Brandis,[1] 8 species were recorded up to 1894. Westwards, the order is represented in the Seychelles by *Vateria seychellarum*. It is curious that, while the order is so conspicuously in an ascending scale as we proceed eastward, the local representatives in Ceylon are confined to our westward side. This peculiarity also applies, as the table indicates, to the greater part of our endemic flora, and presents a feature that cannot be entirely explained by rainfall alone, more especially where, as in the case of this order in particular, we are dealing with gregarious forms.

A careful botanical survey of Moneragalla may disclose a considerable variation in distribution of the endemics on this isolated mass of mountains, more especially with respect to Dipterocarps, as these will be found its southern-most forms to end here.

The *Malvaceae* form a large order in Ceylon, having 12 genera, and 36 species, of which 2 are endemic. *Julostylis* is monotypic, while the small Indian genus, *Dicellostyles*, has our only other endemic representative of the order in *D. axillaris*. *J. angustifolia* has a densely stellate fruit, that does not appear to be animal spread, while the "very rare" *D. axillaris* has a pilose hairy fruit. As suggested elsewhere, the order is abundantly represented in areas where the growth is secondary, the best exception being *Cullenia*, which is a purely forest tree, though not endemic.

The order *Sterculiaceae* is represented in Ceylon by 7 genera and 12 species, of which only one, *Sterculia Thwaitesii*, is endemic. The genus to which this endemic belongs possesses characteristically follicular fruits, generally woody and thick, but the seeds are possibly animal-carried. The brilliant follicles are likely to be attractive, as inviting attention to seeds.

The *Tiliaceae* cover 6 genera, one of which is monotypic, and 30 species, with a total of 7 endemics. Excepting the monotypic eastern form, *Pityranthe verrucosa*, most of our endemics extend up into the hills, but the majority are western. The fruits in *Grewia diplocarpa* do not appear to be specially adapted for transportation, while in *Triumfetta glabra* we find coloured and hooked spines, abundantly covering the pericarp. *Elaeocarpus* is provided with a fleshy epicarp, and is sought after by birds, monkeys, and squirrels, by which agencies species are carried, notwithstanding the rarity of some of the individual endemics themselves. I am doubtful if the eastern record of this genus has been exhausted.

The *Linaceae* is a small order in Ceylon, represented by 3 genera, and 7 species, of which 3 are endemic. *Hugonia ferruginea* appears to be a western form, but I have no knowledge of it. *Erythroxylon acuminatum* (=lucidum, Trim. *Flor.*, Part I., p. 191) is possibly planted, as it is much valued for its medicinal qualities. It is also bird-carried.

E. obtusifolium, which occurs abundantly in the Eastern Province, has a bright scarlet fruit that renders it conspicuous to fruit-eating birds, and possibly bats.

The *Geraniaceae* are represented by 5 genera, and 29 species, of which 18 are endemic. Of these, the transportation of *Biophytum nervifolium* is probably by a creeping process, or if I may use the word, geometridally, as I have found no animals feeding on the plant, other

than insects. It adopts the flat country, and dry areas. *B. nudum*, on the other hand, is common by streams at high altitudes, suggesting water-transportation. *B. proliferum* is gregarious in patches in open spots in the hill country; I cannot offer any explanation of its occurrence.

The genus *Impatiens* has no less than 18 endemic species, more or less associated with wet ground or streams. Seeds may become embedded in mud, and so be carried by such birds as wagtails, but definite data is wanted to support this novel means of seed transit. Many of the larger forms grow by stream sides, and as the capsules open with a spring, seed can be flung off to an appreciable distance. I am not satisfied with the evidence, or I should say *want* of evidence, as to seed dispersal, especially as in the case of *I. repens* we find a type that may be found abundantly growing on wet rocks in one place, and for 10 miles it does not occur again, when it may appear in an isolated spot completely surrounded by high forest. I have found it on a wet slab rock near Yatiyantota at 500 feet altitude, and again on a damp rock at 3,000 feet altitude beyond Lunugala. I do not see a satisfactory means for explaining its appearance in the latter case, where it is isolated. *I. elongata* I found practically on the summit of the precipice-surrounded "Kunadiyaparawitta" mountain. The next nearest place to this point where it has been collected is Adam's Peak. It cannot be supposed that it was bird-carried, as it does not grow in mud, nor are the fruits attractive. The eastern forms are conspicuously badly represented.

The *Rutaceae* in Ceylon are very well represented. We have 13 genera, and 23 species, of which only 2 are endemic, and both of these are recorded only from the eastern section. Both *Glycosmis* and *Murraya*, from which our endemics arise, may be classed as berry-producing, and thereby possibly animal-carried. It is striking, however, that, so widely represented an order as the *Rutaceae* is, with its altitudinally wide-spreading numerous members, endemics are so few. It is difficult to suppose that at one time there were more owing to "foreign competition," as such a conclusion is not borne out by comparison with other orders that are well represented, but are endemically deficient.

The small order of *Ochnaceae* is represented by 2 genera, and 4 species, one of which is endemic. This is the "very rare" *Ochna rufescens*, collected in 1855, and apparently not since found. More material appears to be wanted to decide if this is really a distinct species.

The *Burseraceae* are represented in Ceylon by 3 genera, and 5 species, of which 2, under the genus *Canarium*, are endemic. Of these latter, *C. brunneum* is rather distinct in its selection of soil, as compared with *C. zeylanicum*. *C. brunneum* may usually be looked for on deep rich

soils, in valleys not far from water; *C. zeylanicum*, on the other hand, is most frequently to be found in shallow soil, often on mere crusts of earth overlying slab rock, or on ridges. In both species the fruits are large, conspicuous, and stony. I have seen mynas eating the latter, but it is difficult to understand how such a large seed could be swallowed. Monkeys eat the fleshy exterior, while man appreciates the "nut" of the latter species.

The *Meliaceae* are largely represented in Ceylon. There are 12 genera, and 14 species, of which 4 are endemic. Of the genera, *Pseudocarapa* is monotypic.

It is, however, curious that out of 12 genera only two have as many as two species, leaving all the remainder with but one each. *Munronia pumila* appears to be confined to the dry country, in the east. I have traced it in the valley of the Kumbukkan river, and also west of "Westminster Abbey." I suspect that, owing to its popularity for medicinal purposes, it has been exterminated. It's dispersal is probably geomitridal. *Aglaia apiocarpa* has smooth, orange-coloured berries, attractive to birds. *Pseudocarapa Championi*, having fleshy arils round the seeds, is most likely bird-carried. The trees of this species are lofty, and it is strictly a forest species. *Walsura Gardneri* has ovoid, dull orange fruits, with attractive arils, and is probably monkey-eaten. The southern limit of distribution of this little tree should be looked for, especially at Moneragalla.

The *Olacineae* is another moderately large order, with few species. It is represented in Ceylon by 10 genera, and 13 species, of which only 2 are endemic. *Olax* presents 3 species in Ceylon, and 7 in India. The Ceylon endemic example *O. zeylanica* is, however, a small tree, with very bright scarlet, attractive fruits. It occurs both in the wet and dry-zones, but more abundantly in the former; it is bird-eaten. *Apodytes Gardneriana* is fairly common; it's small fruits are possibly bird-eaten.

The *Celastraceae* are represented in Ceylon by 11 genera, and 19 species, of which 6 are endemic. Of the endemics, *Euonymus* alone contributes 3. These are *E. revolutus*, *E. Thwaitesii*, and *E. Walkerii*. Their method of seed dispersal is not clear, nor can any of them be regarded as common. The coloured inner coat of the capsule conspicuous in *E. Walkerii*, may be bird-attractive. I have found a nest in a tree of this species, but I am unable to say if I have found evidence of the seeds being bird-eaten.

Microtropis Wallichiana appears to be bird-eaten, and is a widely distributed little tree.

Gymnosporia fruticosa appears to have been found only once, and that by the side of a river.

Kurrimia zeylanica is bird-eaten, especially by mynas. Its eastern distribution is probably much larger than my tables show.

The *Rhamnaceae* in Ceylon afford 7 genera, and 12 species, of which 2 are endemic. These are *Zizyphus Napeca*, and *Rhamnus Arnottianus*. The former of these two, if identical with the plant I obtained at Hiripitiya in the North-western Province, is certainly bird-eaten, Barbets being fond of it. *R. Arnottianus* is certainly bird-carried, as its fruits are attractive.

The small order of *Ampelideae* has in Ceylon only 2 genera, but 20 species, of which 5 are endemic. There appears to be no reason to suppose that the fruits of any of these endemics are not animal-eaten, so that their transportation can be so accounted for, but it is not so evident why the greater number of species should be more common at the low levels than at high. This may be a matter of rainfall, as there is certainly a tendency for the order to be better represented in the dry-zone.

The *Sapindaceae* are represented by 11 genera, and 19 species, of which 5 are endemic. One of the genera supplies the monotypic *Gleniea*. Of the endemics, the genus *Allophylus* has one, out of 3 species. This is *A. hispidus*, which, according to Trimen, is rare. The fruits of this genus are coloured, and bird-eaten. *Gleniea zeylanica* is exceedingly common in the dry country, especially in the east and south-east. It's fruits are eaten by birds, and Orioles often select its branches for nesting. *Sapindus erectus* is yellow-fruited, and much bird-eaten. *S. Thwaitesii* I have not seen, but probably the fruits are bird-carried.

The order *Anacardiaceae* is made up of 7 genera, and 19 species in Ceylon, of which the high proportion of 15 are endemic. Of these no less than 13 belong to the genus *Semecarpus*, completely absorbing the whole of that genus. Taken in their order, *Mangifera zeylanica* is our only indigenous mango; the fruits are eaten by monkeys, as well as by man. I have observed a considerable variation in the size and colour of the fruit of this widely-spread forest tree, having obtained both yellow and purple fruits. In the dry zone, the wild mango is not so abundant as in the damp forests of the west, but, as its timber is made use of for the manufacture of tea boxes, it is not unlikely to be wiped out in accessible localities. In *Semecarpus*, the fruits are all more or less possessed of a fleshy (and in some cases attractively coloured) receptacle. This probably helps in their transportation, though it is remarkable that the poisonous acid contained does not appear to react against diffusion. Our genus appears to be more confined to the wet country than the dry. Some are found commonly by streams and marshes. *Campnosperma zeylanicum* is practically a wet-country tree,

growing gregariously. It's fruits are small, pulpy, and pigeon-eaten. It appears to thrive in very poor soil, and is a "surface feeder." Its great popularity for packing-case manufacture may probably exterminate it, as it is not a widely-distributed tree.

The *Connaraceae* afford 3 genera, and 4 species, of which 2 are endemic. These are *Connarus Championii*, and *Ellipanthus Thwaitesii*, both of which have conspicuous arils and consequently are attractive to animals.

The great order of *Leguminosae* is, in Ceylon, represented by 64 genera, and 207 species, of which only so few as 12 are endemic. *Pericopsis* alone is monotypic. While most of the genera have many species, yet the endemics are curiously few, as for example, *Crotalaria* has 23 species, but only 2 are endemic ; *Desmodium* has 21, and 2 endemics ; *Indigofera* has 16 species, but no endemics ; *Cassia* 12, and no endemics ; and equally no endemics among the 9 Acacias. It may be remarked, however, that the majority of the species of this large order are deficient in fruits that are eaten by animals, but this, while it may restrict distribution, does not apparently account for the comparative scarcity of endemics. Assuming that our collections are tolerably representative of distribution, it will be seen that our endemics are not specially confined to any particular altitude and in that way they agree with the general spread of the non-endemic forms. Our monotypic *Pericopsis* is certainly a wet-zone plant, and confined to low altitudes, but numbers of non-endemic leguminous plants are also abundant in the lower wet-zone. Broadly speaking, this order presents infinite difficulty in accounting for the means of dispersal, while the abundance of individuals makes it the more obscure how this distribution is to be accounted for.

A comparison between this large order and the *Rubiaceae* discloses some interesting contrasts, as follows :—

Order	Total Genera	Mono-typic	Species		Total Species
			Non-endemic	Endemic	
Leguminosae	64	1	195	12	207
Rubiaceae	47	4	67	71	138

It will be here observed, that while the fruits of the *Leguminosae* may be broadly described as non-attractive, those of the *Rubiaceae* are mostly fleshy, or likely to be freely sought after. It may be possible to account for the excess of the rubiaceous endemics on the ground that more individual plants are planted by this method of dispersal than in the case of the *Leguminosae* ; and carrying the comparison further to

the *Euphorbiaceae*, we find some confirmation, as the following figures tend to show :—

Order	Total Genera	Monotypic	Non-endemic Species	Endemic Species	Total Species
Euphorbiaceae	43	0	85	45	130

It will at once be observed that no monotypic genus appears, but, on the other hand, the endemic species are very fully represented, especially as the attractive-fruited forms are, as in the *Leguminosae*, proportionately fewer. It is suggested that while an abundance of seedlings are massed together, the struggle for existence must obviously be greater, thus tending towards development of specially varied characters to secure the preservation of the race. This speciality, may, in repeated races, be so far developed as to constitute a specific difference so marked as to constitute a distinct species, till in time it becomes, in itself, a definite product of congestion.

Against this theory, however, is the fact that *Strobilanthes* is not a fleshy-fruited genus, yet we have 25 endemics. On the other hand, at least some of the *Strobilanthes* are bird-eaten.

Returning to the *Leguminosae* and their local endemic distribution, it will be observed that four genera carry two endemics apiece, and four only one each. The most characteristically hill form is *Sophora zeylanica*, and it may be noted that the seeds are " bright dark red." *Pericopsis Mooniana*, a magnificent wet-zone monotypic plant, runs very considerable risk of extermination. It is in great demand for furniture, and is one of the finest and most durable of our woods, and if its exploitation is not closely controlled, or its artificial propagation extended, it will soon share the fate of the Calamander.

The *Rosaceae*, in Ceylon, are represented by 7 genera, and 12 species, of which 3 are endemic. These latter are *Pygeum*, *Poterium*, and *Agrimonia*, of which the first is a tree, fairly common in the low wet-zone, and the last two are herbs. The last, *A. zeylanica*, is to be found in open grassy land, its method of fruit dispersal is not known.

The *Haloragaceae* is another small order. It is represented by 3 genera, and 4 species, of which the one endemic, *Serpicula zeylanica* occurs at a high altitude. The fruits of the latter are minute, and their method of transportation is unknown. Its presence on the top of Adam's Peak, and on the opposite mountain, Kunadiyaparawitta, is curious.

The *Rhizophoraceae* family, in Ceylon, is made up of 6 genera, and 10 species, of which 2 are endemic.

With the exception of *Anisophyllea*, all our local members of this order are swamp, or damp-ground, loving species, of which *Rhizophora* (" Mangrove ") is a brackish-water example. Of the endemics, *Carallia calycina* is a large tree, having small red fruits that are probably eaten by pigeons ; it is not plentiful. *Anisophyllea zeylanica*, on the other hand, is a common endemic, chiefly found in the wet-zone ; I am unacquainted with the manner of its fruit dispersal. I am not satisfied with its eastern distribution, shown in my tables, as I expect this common plant will be found to occur in the Nitre Cave Valley, and near the foot of the eastern flank of the Rangalla hills.

The *Combretaceae*, in Ceylon, are represented by 5 genera, and 11 species, of which one only is endemic. This is *Terminalia parviflora*, a fairly well-distributed forest tree in the west. I have doubtfully included it in my eastern distribution, as I remember to have seen it in the east, though unfortunately I did not record the locality. The fruits of this species are bird-attractive.

The *Myrtaceae* form, in Ceylon, 4 genera, and 49 species, of which 30 are endemic ; and of these, no less than 29 belong to the genus *Eugenia* alone. The whole order has attractive fruits, especially among the Eugenias, which are readily eaten by birds. My tables will show that these endemics are widely distributed altitudinally, even though the eastern section shows so few. I have duly recorded the " rarity " of the individuals, but I think that the fact that we have a characteristically fleshy-fruited, many-seeded genus here typically illustrated, it, to some extent, supports the theory I have attempted to show. In the case of the last endemic in this order, *Barringtonia zeylanica*, we have a water-loving species, with fruits that are easily water-carried, though not so definitely as in the non-endemics, *B. acutangula*, or *B. racemosa*.

The *Melastomaceae* form a large order from the point of view of species and endemics. It has 6 genera, and 52 species, of which 36 are endemic, only two genera being *un*represented endemically.

Osbeckia has 5 endemics out of 9 species, *Sonerila* 8 out of 12 ; *Medinilla* 2, or the entire local genus ; and *Memecylon* 21 out of 27.

Of the Osbeckias, the majority of our endemic forms are montane. It is unfortunate that our data, as regards the eastern distribution, are so bare, as it can hardly be supposed that none occur there. The capsular fruit is not, as far as I am aware, ever bird-eaten, while the seeds, which are very abundant, may possibly be water-carried, but at present I am ignorant of any special method of dispersal, other than geomitridal, for their transportation. It is possible that ground-feeding birds, such as jungle fowl, spur fowl, and bronze-wing pigeon, may eat the fruits of Osbeckias, but no cases that I am aware of have been proved of this.

In *Sonerila* we have well distributed examples. The problem of dispersal is perhaps more obscure than the last, owing to the singular situations where the plants are found, such as steep banks, rock crevices, mossy decayed logs, and the like. The seeds are always numerous and minute, but, as far as I am aware, are not wind-carried. I have found small caterpillars in the same places as Sonerilas and plentiful, but I have found no example of their feeding on these plants.

Medinilla fuchsioides is, I am certain, bird-carried. I have observed *Diceum* hunting along its branches for fruits, much in the same way as it explores *Loranthus*. *M. maculata* may be carried in the same way. The fruits of both these species are coloured and attractive.

The well-represented genus, *Memecylon*, is very well distributed altitudinally, though a number are, so far, described as " rare." The fruits of this genus are all berries, and more or less conspicuously coloured, and it may be noted that the " very rare " *M. phyllanthifolium* has very minute fruits. I think that owing to the abundant fruiting habit of the genus as a whole, and the attractive nature of the fruits to birds, a parallel to the abundance of endemics in the genus *Eugenia* is to be found here. In reality, if we take the ratio of 29 (total endemics) to 43 (total species) in *Eugenia*, and 21 (total endemics) in *Memecylon*, we get 31 as the proportionate number of species in the latter. In reality we have 27. Conversely, as 43 (total species in *Eugenia*) is to 29 (total endemics in *Eugenia*), so is 27 (total species in *Memecylon*) to 18, and we have actually 21. As we cannot be dealing with complete data, and the units themselves possess their own personal equation, the above results are not by any means unsatisfactory, even if they are not convincing.

The *Lythraceae* in Ceylon are expressed by 7 genera, and 15 species, of which one is endemic. This is *Axinandra zeylanica*, a curiously isolated form, that occurs in the wet country up to 2,000 feet.

The *Samydaceae* are made up of 3 genera, and 5 species, of which 2 are endemic, viz., *Casearia coriacea*, and *Osmelia Gardneri*. Both have coloured fruits.

The *Cucurbitaceae* family is very well represented in Ceylon as regards numbers, but badly so with endemics. There are 17 genera, and 26 species, 3 of which latter are peculiar to the country. Of these, *Trichosanthes integrifolia*, is a powerful climber, with brilliant crimson fruits that are eaten by monkeys. *Momordica denudata* is another climber with striking fruits, and the last, *Melothria zeylanica*, is a third scandent species, of a wide altitudinal distribution. It is rather remarkable, with so large a number of conspicuous fruited plants, that we have so few endemics, but this may be counter-balanced by the fact that so many are annuals, and the majority affect areas that are fre-

quently subjected to the process of " cultivation " known as chenaing. This process, added to an annual habit, may materially lessen congestion of individual forms.

The *Umbelliferae* family is made up, in Ceylon, of 7 genera, and 10 species, of which only two are endemic. It will be seen that none of the genera are large, 3 being the maximum number of species. The whole order is diminutive. Our two endemics, *Peucedanum zeylanicum* and *Heracleum zeylanicum*, belong to our higher altitudes and are unattractive as regards their fruits.

The *Araliaceae* are here represented by only 2 genera and 5 species, one of which, *Heptapleurum emarginatum*, is an epiphytic form, with small, but bird-attractive, fruits. The *non*-endemic *H. exaltatum* is a large tree rather characteristic of Uva, where it occurs in the small isolated patches of forest that are found in the Patana lands.

The *Cornaceae* is another small order, having in Ceylon 2 genera, each of 2 species, with one endemic in each. These are the climbing shrub *Alangium glandulosum* and the tree *Mastixia tetrandra*, of which last, a variety (?) is common in the wet forests in the west from 1,000 to 6,000 feet altitude. I am unacquainted with the mode of dispersal in both these.

The very large order of *Rubiaceae* is represented in Ceylon by 47 genera, and 138 species, of which so many as 71 are endemic. Of the genera, 4 belong to the Island. The order has some very large tree forms, as well as minute, shade-loving, dingy plants ; some devoted to the wet-zone, others thriving in the dry, under the driest conditions.

The altitudinal distribution is very evenly shown, though I have again to deplore the paucity of data as regards eastern figures, where I am certain much revision is necessary. The fruits in this order may be classed as bird-attractive, and in that way most probably secure wide distribution, except where herbaceous forms are concerned. Dispersal by water is also quite possible, as in *Schizostigma*, which is an essentially wet country plant, growing in places reeking with active moisture. The very remarkable monotypic *Leucocodon reticulatum*, with its epiphytic habit, and fruits immersed in natural cups of water, presents a curious problem to account for its presence, or its dispersal, as it is unlike any other member of the order.

Scyphostachys is another genus peculiar to the Island, that appears to have affinity with *Coffea*, and has, like that important genus, attractive fruits. The monotypic *Nargedia* appears to be very rare ; I am unacquainted with its habits or fruiting.

Comparing the proportion of endemics in the *Rubiaceae*, with that in other large, endemically well-represented orders, it will be seen that

it is surpassed in the orchids, and that fact may be taken as destructive to the theory I have advanced on the fleshy fruit basis ; but I submit that, in the *Orchidaceae*, we have a family in which the seeds are not only extraordinarily abundant, but extraordinarily small, and are therefore wind-carried. This subject will be found more fully dealt with further on.

In *Dipsacaceae*, we have a solitary genus, and only one species, which is endemic. Its fruits are dry, and our form is montane.

The great order of *Compositae* is very well represented in Ceylon by 36 genera, and 78 species, of which 19 are endemic. It will be observed that the average number of species per genus is only about 2.2. The largest genus is *Vernonia*, with 13 species, out of which 9 are endemic, while, on the other hand, we have no indigenous genera. The whole order has the characteristic of abundant seed, and these wind-carried. As regards our endemic *Compositae*, as might be expected, more are to be found in the hill country than in the plains. Of the non-endemic species, of which we have 59, it may be observed that get the following :—

From	sea-level	to	1,000 ft.	.. ..	15
,,	1,000	to	2,000 ft.	.. ..	2
,,	1,000	to	3,000 ,,	.. ..	2
,,	1,000	to	4,000 ,,	.. ..	6
,,	1,000	to	5,000 ,,	.. ..	2
,,	1,000	to	6,000 ,,	.. ..	8
,,	1,000	to	7,000 ,, & over	.. ..	4
,,	2,000	to	3,000 ,,	.. ..	1
,,	2,000	to	4,000 ,,	.. ..	1
,,	2,000	to	5,000 ,,	.. ..	0
,,	2,000	to	6,000 ,,	.. ..	0
,,	2,000	to	7,000 ,,	.. ..	0
,,	3,000	to	4,000 ,,	.. ..	1
,,	3,000	to	5,000 ,,	.. ..	0
,,	3,000	to	6,000 ,,	.. ..	1
,,	3,000	to	7,000 ,, & over	..	2
,,	4,000	to	5,000 ,,	.. ..	0
,,	4,000	to	6,000 ,,	.. ..	1
,,	4,000	to	7,000 ,, & over	..	8
,,	5,000	to	6,000 ,,	.. ..	0
,,	5,000	to	7,000 ,, & over	..	5
,,	6,000	to	7,000 ,,	.. ..	0

(These figures are arranged in these groups, so as to shew individual ranges, without repeating the altitude against the individual continually). Taking all below 4,000 feet, *i.e.* 1,000 up to 4,000 feet, we get 28 non-endemic species, and above that level we have 31. The endemics, on the other hand, show more forms above the 4,000 feet limit than below that altitude.

Of the *Myrsineae*, Ceylon has 5 genera, and 14 species, of which 3 are endemic and confined to the genus *Ardisia*, which is our largest genus in this order. The Ardisias all have berries, more or less attractive, and are chiefly distributed in the wet-zone.

The *Sapotaceae* order is one of trees in this Island, and is made up of 6 genera, and 17 species, of which 11 are endemic, spread over two genera. It is probable that further material may be obtained to lead to *Isonandra* being found to have endemic species among those now classed as varieties of *I. lanceolata* by Trimen. These are to be sought for in the wet forests of the Singha Raja, and in the " Peak Wilderness." *Bassia neriifolia* is a gregarious, water-loving endemic, abundant by river-sides in the lower parts of the wet-zone, extending, in the case of the Walawey River, up to nearly 2,000 feet. Like the rest of the genus, it has comparatively large fruits that are animal-attractive.

The whole seven species of *Palaquium* are indigenous, and all carry attractive fruits. *P. petiolare* attains a very large size, and is, in certain localities, to some extent gregarious. *P. rubiginosum* is distinctly so, at high altitudes. The fruits of this genus are strongly attractive, and are eaten by mynahs and jays. *P. grande* is a water-loving form.

Our important order *Ebenaceae*, though widely distributed, has only two genera, and 24 species, of which 11 are endemic, *Maba* having 3 out of 4, and *Diospyros*, 8 out of 20 species.

Of *Maba*, I have found *M. acuminata* plentiful in restricted areas in the wet-zone in the south. It's fruits are small, and possibly bird-eaten, but as I have found the plant more common by water, I suspect dispersal is effected by that means. I have not seen the fruits of the other two endemic Mabas, but the non-endemic and abundant *M. buxifolia* is certainly bird-eaten.

Diospyros attenuata, though not generally plentiful, is locally abundant. It may be said that the ranges of hills in the Pasdun Korale that culminate in the " Haycock " mountain possess more examples of this genus than any other part of Ceylon. The special reasons for this are not clear. These particular hills are steep, rocky, and in a very wet

part of the Island. That fruits of this genus are carried down by gravity, added to the movement of water, I have had evidence of both at Hewissa, and Borulugoda, and at the foot of Tittaweraluwakotta and Linigalla ; and at all these places I have found examples of different species of *Diospyros*. *D. Gardneri* is fairly common in, and beyond, the country just referred to, and often found near streams. *D. quaesita* I have only found in fruit in two places, viz., near Kokawitta in the Kukulu Korale, and at Karawita Kanda. This beautiful tree has suffered sadly, owing to the beauty of its handsome timber, so well-known under the name of " Calamander," and its present scarcity is probably due to its popularity, especially in Dutch times. The first examples of female flowers, as far as I know, were obtained in the Atakalan Korale, where I obtained them, and these were afterwards figured by Wright.[6] I may add, that for three years I offered a reward to anybody who would show me the fruits, *in situ*, of *D. quaesita*, but the offer failed to secure a single candidate. When I did find the tree in fruit (and this I may add was in an almost inaccessible mass of rock ground), I found that there was a most remarkably high percentage of mortality among seedlings that I raised from the seed, so that the question of dispersal is more than ever obscure. *D. hirsuta* and *D. Thwaitesii* are both found near streams, but only in the wet-zone, while *D. Mooni* I have found generally to affect the margins of swamps, or very wet ground. Unlike most of the non-endemic species of *Diospyros*, the endemics appear to be most abundant where the rainfall is very considerable, suggesting a water habit.

It will be noted that *D. Embryopteris* and *D. Toposia*, are both, to a marked extent, water-loving non-endemics, both being found by streams, though *D. Toposia* is not found in the eastern half of Ceylon. I have repeatedly found fruits of *D. Embryopteris* that had evidently been water-carried in the beds of non-perennial streams, but as the whole genus has light, ovoid, or spherical fruits, that are attractive, their transportation may not depend on water alone.

Our *Styraceae* form a single genus of 20 species (19 according to Trimen), of which 17 are endemic. The fruits are all bird-attractive. It is, therefore, the more remarkable that the eastern distribution is not better shown. The genus appears to be more confined to altitudes over 3,000 feet, than below.

Of the *Oleaceae* Ceylon shows 4 genera, and 12 species, of which one *Linociera purpurea*, a tree, is endemic. With the exception of this and

one other, the order is confined to climbers and small bushes. The fruits are not attractive, or appear not to be so.

The large order *Apocynaceae* is represented, in Ceylon, by 19 genera, and 25 species, of which 8 are endemic. Of these 19 genera, 15 have only one species in each ; 3 have two each ; while *Wrightia*, the largest with 4 species, supplies 3 out of the 8 endemics.

It may also be observed that the order, as represented in Ceylon, can only count 5 tree forms, 2 low plants, 9 that can be classed as bushes, and 9 that are creepers. Of the endemic forms, *Willughbeia zeylanica* is a very large creeper, that affords copious latex, and big pink fruits, that are devoured by monkeys. *Alyxia zeylanica* is a small plant, bearing brilliant scarlet poisonous fruits. *Holarrhena mitis* is one of the few trees of the order, with comose seeds ; *Wrightia flavido-rosea*, *W. zeylanica*, *W. angustifolia* are all of the bush class, and all have wind-carried seeds. *Baissea acuminata* is semi-climbing, and also wind-carried; and *Anodendron rhinosporum* may be also classed as a climber, and possesses seeds that are pre-eminently adapted to distant flight. The other members of the family have not such marked facilities for dispersal in all their units, and this may have its influence in a diminished number of species per genus, though it must be admitted that four of our endemic apocynaceous plants are the only Ceylon species in the genus in which such occurs.

The *Asclepiadaceae* is another of our large Ceylon orders. It is represented by 22 genera, and 39 species, of which 7 are endemic. It will be noted that of the genera, 17 have only one species in each, and that the largest number of endemics in any one genus is in the genus *Tylophora*, which has the greatest number of species. Moreover, it may be observed, that no examples of the order are trees, and that our representatives are composed of 3 bushes, 5 herbs, and 31 twiners. For dispersal, they have the advantage of possessing air-carried seeds, but with so many forms in which the climbing character is restricted by comparatively short stems, the chances of wide dispersal appear to be restricted. Moreover, many of the order occur in "Chena" lands, which, by being periodically burned, must by that circumstance cause the destruction of established, as well as young plants. As this order might be well compared with the *Compositae* in the matter of dispersal of its seed, both being wind-carried, I have compiled the following figures showing the percentage of non-endemics in both these orders, and at their respective zones of altitude :—

Altitude	Composites		Asclepiads	
	Number	%	Number	%
At 1,000 ft.	15	25.42	10	31.25
From 1,000 to 2,000 ft.	2	3.39	4	12.50
,, 1,000 to 3,000 ft	2	3.39	6	18.75
,, 1,000 to 4,000 ft.	6	10.17	4	12.50
,, 1,000 to 5,000 ft.	2	3.39	2	6.25
,, 1,000 to 6,000 ft.	8	13.56	—	—
,, 1,000 to 7,000 ft. & over	4	6.78	—	—
At 2,000 ft.	—	—	1	3.12
From 2,000 to 3,000 ft.	1	1.69	1	3.12
,, 2,000 to 4,000 ft.	1	1.70	1	3.12
,, 2,000 to 5,000 ft.	—	—	—	—
,, 2,000 to 6,000 ft.	—	—	—	—
,, 2,000 to 7,000 ft. & over	—	—	—	—
At 3,000 ft.	—	—	—	—
From 3,000 to 4,000 ft.	1	1.69	—	—
,, 3,000 to 5,000 ft.	—	—	—	—
,, 3,000 to 6,000 ft.	1	1.69	—	—
,, 3,000 to 7,000 ft. & over	2	3.39	—	—
At 4,000 ft.	—	—	2	6.25
From 4,000 to 5,000 ft.	—	—	1	3.12
,, 4,000 to 6,000 ft.	1	1.70	—	—
,, 4,000 to 7,000 ft. & over	8	13.56	—	—
At 5,000 ft.	—	—	—	—
From 5,000 to 6,000 ft.	—	—	—	—
,, 5,000 to 7,000 ft. & over	5	8.48	—	—
At 6,000 ft.	—	—	—	—
From 6,000 to 7,000 ft. & over	—	—	—	—
	59	100.00	32	100.00

In consideration of the fact that Composites are a temperate zone order, and the Asclepiads are tropical, it might be expected that the former would show a larger proportion of plants at high altitudes than the latter. The tables very well illustrates that this is actually the case with our Ceylon members of these two families. A reference to the concluding tables will show the altitudinal distribution of the endemics of both these orders and this needs no further comment here.

The order *Loganiaceae*, in Ceylon (here I follow Trimen as I have had no access to the revision of the order), is represented by 4 genera, and 14 species, of which 6 are endemic. The largest genus is *Strychnos*, which affords 3 indigenous species, as does *Gaertnera*. With the exception of *Mitrasacme*, which has a capsule, all are fleshy-fruited, but to what extent they are eaten by animals, I am in ignorance. None of our endemics in this order are found in our higher hills, with the exception of the shrubby *Gaertnera Walkeri*, which has bird-attractive (?) blue fruits.

The Ceylon members of the *Gentianaceae* are made up of 8 genera, and 19 species, of which 5 are endemic. *Exacum* is the largest genus, and affords 4 endemics, the remaining endemic being *Swertia zeylanica*. The whole order, with the solitary exception of *Crawfurdia* (and this appears to be almost extinct, judging by its "rarity") has capsular fruits. The transportation is difficult to account for. Possibly some of our forms may be water-carried, but this is uncertain, as so many are found growing in steep banks, and places where, though the soil is damp, there is no actual water in movement. On the other hand, I have found Gentians in swampy, wet ground.

The *Boraginaceae* is a moderately large order of 8 genera, and 18 species, of which only 2 are endemic. *Cordia* is the largest genus, having 5 species, one of which is peculiar to the country, the other endemic is *Tournefortia Walkerae*. Both the endemic species bear fruits that may be animal-eaten, and have hard seeds. None of our examples of this order occur in the highest parts of the Island.

The *Convolvulaceae*, in Ceylon, form 11 genera, and 46 species, of which only 3 are peculiar to the country. Seven of the genera only afford one speices each, while *Ipomaea* has no less than 29, of which *one* is endemic. The whole family are climbers, and excepting the parasitic *Cuscuta* do not possess attractive fruits; moreover, they are mostly short-lived.

I have no evidence to show that the fruits are ever animal-eaten, and I assume that transportation is mostly effected geomitridally, *Cuscuta* excepted, and this I think is bird-carried.

It is remarkable that, so well represented a family as the *Solanaceae* is, it has no endemic forms in Ceylon, and has the advantage of attractive fruits. It may be assumed that the fruits are poisonous, but this suggestion needs corroboration. I have frequently seen the fruits of these plants fallen on the ground and left untouched.

The large family of the *Scrophulariaceae* is, in Ceylon, represented by 16 genera, and 40 species, of which only 2, confined to *Adenosma*, are endemic. These two are confined to the low-country. The fruits

of these species are unattractive, and the species may be conveniently described as affecting swampy, or damp ground. Out of such surroundings, they do not appear to thrive, and consequently do not spread.

The curious family of root parasites, the *Orobanchaceae*, contains 3 genera in Ceylon, with 8 species, of which so far 3 are found to be endemic. It appears to be quite probable that the order may be found to be even larger than our records show, and a careful exploration of the " Peak Wilderness " will, I believe, result in the discovery of more. As I have no knowledge of the life-history of these curious plants, I can express no opinion as to their seed dispersal, or their seeming partiality for " Nellu " as a host.

The *Gesneraceae* are well represented in Ceylon by 7 genera, and 12 species, of which one genus and eight species are endemic. It will be observed from the tables that our indigenous forms, under this order, are well distributed, while it is equally noticeable that the fruits are not attractive, nor are the plants themselves more than herbs. *Didymocarpus Humboldtianus* is, in suitable places, equally well distributed in both sides of the Island, I have found it growing freely inside a small shallow cave on the side of the exposed wind-swept rock known as Koudagalla, to the north of Punnani in the Eastern Province, and again in very similar situations on the great cliff of " Westminster Abbey, " in the south. It is not clear how, with such barren surroundings, this minute plant should appear at such remote places, and flourish. In the case of Koudagalla rock, the little cave where I found it is near the summit of the mountain, that is quite exposed to very severe tempests of dry wind. *D. zeylanicus* occcurs in abundance in damp shady banks in the valley of the Maskeliya ganga, near the Laxapana mountain. I preserved and grew several examples, but failed to raise seedlings.

The very handsome-flowered *Chirita Moonii* I have repeatedly obtained on wet rocks, where it grew in the crevices. *C. zeylanica* is fairly abundant, and seed-capsules, that I suspect as belonging to this, I have found in a manner suggestive of wind-transport.

Championia reticulata, our monotypic and endemic genus, is apparently confined to the very wet parts of the Sabaragamuwa Province, while *Klugia zeylanica* may be regarded as water-loving. The latter has membranous light capsules, easily water-carried.

I am unprepared to show satisfactory proof of the means of dispersal of seed in this family, but the deficient data I have is suggestive of the capsules being wind-carried in some, or water-carried in others. It is noteworthy that our non-endemic *Aeschynanthus zeylanica* is often found growing on the branches of trees.

The very large order *Acanthaceae* is, in Ceylon, represented by 29 genera, and 93 species. Of these, 39 are endemic, and one of the genera is monotypic.

The distribution of the whole order is remarkable. Of the endemics, as contrasted with the non-endemics, we have the following altitudinal range :

Range.	Endemic		Non-endemic	
	Number.	%	Number.	%
From 0 to 1,000 ft.	2	5.13	29	35.70
1,000 to 2,000 ft.	5	12.82	4	7.41
1,000 to 3,000 ft.	3	7.69	7	12.96
1,000 to 4,000 ft.	3	7.69	—	—
1,000 to 5,000 ft.	—	—	—	—
1,000 to 6,000 ft.	1	2.56	—	—
1,000 to 7,000 ft. & over	—	—	3	5.55
2,000 ft.	1	2.56	—	—
2,000 to 3,000 ft.	2	5.13	2	3.70
2,000 to 4,000 ft.	3	7.69	3	5.55
2,000 to 5,000 ft.	1	2.56	—	—
2,000 to 6,000 ft.	—	—	1	1.85
2,000 to 7,000 ft. & over	—	—	2	3.70
3,000 ft.	3	7.69	—	—
3,000 to 4,000 ft.	1	2.59	—	—
3,000 to 5,000 ft.	—	—	—	—
3,000 to 6,000 ft.	2	5.13	—	—
3,000 to 7,000 ft. & over	1	2.56	1	1.85
4,000 ft.	2	5.13	—	—
4,000 to 5,000 ft.	—	—	—	—
4,000 to 6,000 ft.	1	2.56	—	—
4,000 to 7,000 ft. & over	3	7.69	—	—
5,000 ft.	—	—	—	—
5,000 to 6,000 ft.	—	—	—	—
5,000 to 7,000 ft. & over	1	2.56	—	—
6,000 ft.	1	2.56	—	—
6,000 to 7,000 ft. & over	3	7.69	2	3.70
	39	100.00	54	100.00

From the above table it will be observed, that while our endemics are nearly equally divided in point of number of species up to 3,000 ft. altitude, the non-endemics practically belong to the lower levels, the contrast being more striking in the high ratio at the lowest range of non-endemics to endemics.

In habit, the whole order may be described as gregarious, but in *Strobilanthes* in particular, we find the additional limiting peculiarity of the plants only seeding at long intervals of time. This peculiarity must, to a great extent, affect the spread of seed. In connection with this phenomenon, I may add, that I have on two occasions of the fruiting of *Strobilanthes* found them to synchronise with plagues of rats, that vanished after the seed crops were over. I have also observed that during the season of seeding, jungle fowl were in extraordinary abundance, besides other ground-feeding birds. The non-endemic *Stenosiphonium Russellianum* also has its seeds eaten by the jungle fowl, which I have no doubt spreads it. The fruit dispersal of some of our species requires further examination, as it appears uncertain if the seeds of all are bird-eaten, or if some of them are not wind-carried.

The *Verbenaceae* is a moderately large order of 13 genera, and 26 species, of which only three are endemic. Two of these, however, belong to the largest genus.

The remarkable spread of our introduced *Lantana* is an instance of how an unrestrained species can overspread large areas, practically to the exclusion of others. *Lantana aculeata* is said to have been brought to Ceylon in 1826. It is now a common weed, of extraordinary abundance, extending from sea-level into the hill country, especially in the moist regions. It has been spread by birds, its fruits being eaten by many kinds, and it is only in recent years that it appears to have been, to some extent, checked by blight. Its allied form, *L. indica*, on the other hand, is exceedingly rare.

Equally common is the probably-introduced *Stachytarpheta indica*, that grows as a wayside plant, plentifully, but its method of seed dispersal is not obvious. *Callicarpa indica* is bird-carried, but not in abundance.

Premna, our largest genus, is practically confined to the low-country, *P. tomentosa* alone extending into the hills, though in the matter of abundance it is more of a low-country plant than otherwise. The endemic forms, *P. Thwaitesii* and *P. procumbens*, are both rare. Without specially detailing the individuals themselves, it may be said of the order, as a whole, that the fruits are attractive ; but the majority of its members are not strictly forest plants, and probably suffer much artificial destruction in consequence. The outstanding exception is *Vitex altissima*, it being found in forest lands and chenas alike. *Avicennia officinalis* is water-loving, and mangrove-like in habit.

The *Labiatae* form another large family in Ceylon, of 16 genera, and 42 species, of which 10 are indigenous. The genera are mostly small, in point of number of component species. *Plectranthus* and *Pogostemon*

supply three endemics each ; *Anisochilus* and *Scutellaria*, one each ; and *Coleus* two.

The method of seed transportation is not very clear, in view of the uninviting nature of the fruits. That some are water-carried, appears to be probable, but this can not be the case in certain forms of a sub-gregarious habit, where possibly the geomitridal method of spreading those particular types may account for them. I find that Pearson, in his Ceylon Patana flora, enumerated no less than nine of the order as occurring in our high-altitude grass lands alone, the open-land habitat being generally characteristic of the whole family.

The *Amarantaceae* comprise 11 genera, and 25 species, of which 3 are endemic in Ceylon, these last being confined to solitary examples in these genera. The whole family belongs to low altitudes, and, as many are eaten by the people in their curries, it is probable that these are, to some extent, man-spread. Several forms are found by water, making it likely that the light seeds are dispersed by this agency.

The *Podostemaceae*, to which family Dr. Willis has devoted much labour, is represented by 5 genera, and 7 species, of which 2 are endemic. All are water plants, attached to rocks and stones that become affected by the rise and fall of the water, according to the corresponding fluctuations of rainfall ; thus, at certain periods, the plants are continuously under water, while in the very dry weather they are exposed, and dry up. It is at this season that " the flowering and fruiting occurs."

The order *Nepenthaceae* has, in Ceylon, one genus and one species. This has been referred to already. It is a wet-zone plant, and common in wet soils. I am inclined to think that the form found in some of the Sabaragamuwa forests (in the Kukulu Korale, and at Hewissa, especially) may be found to be a distinct variety, as it is very much larger, and more a forest plant than the common *N. distillatoria*. The minute seeds are apparently water-carried.

The complicated order, *Piperaceae*, is composed of 2 genera, and 14 species, of which last 5 are endemic. Both climbing and herbaceous plants are represented by the Ceylon examples of this order, the former numbering 8 and the latter 6 species. The fruits in the climbing section are distinctly attractive, and may be bird-carried, but of this I have no proof. In the herbaceous group, on the other hand, the fruits are minute and inconspicuous, so that how these forms come to be found on isolated rocks, or on dead stumps of trees, is by no means clear. *Piper peltatum*, though not peculiar to the Island, occurs in ravines as a solitary (or at most so) plant at elevations up to 4,000 feet. Its occurrence in such places is remarkable.

The little order, *Myristicaceae*, is confined to one genus with 4 species, of which 2 are endemic. The first of the endemics, *M. zeylanica*, is uncommon. I have found it in the Eastern Province, at a little above sea-level, while *M. Horsfieldia* is tolerably abundant in the wet-zone. The fruits are eaten by mynas, and are also water-carried.

The *Monimiaceae*, which appear to be Malayan as well as Ceylonese, is represented here by the endemic genus *Hortonia*, of which we have two species. Of these, one is a water-side plant growing abundantly by streams in the west of the Island in the low wet-zone, and the second occurs in the forests of our western hills, above 4,000 feet. It will be noticed that, like the Dipterocarps, these plants, though allied to Malayan examples of the same order, adopt our western side of the country only.

The *Lauraceae* are represented by 10 genera, and 33 species, of which the large proportion of 23 are endemic. They may be classed as shrubs and trees, and all possess fruits that are bird-eaten. The altitudinal distribution of endemics and non-endemics is best understood by reference to the table on the following page.

It will here be seen that our endemic forms are much more abundant in the hill than in the low-country, while our non endemics scarcely appear above 2,000 ft.

The well-known cinnamon, though not peculiar to this Island, was probably much more widely distributed locally than at present; but owing to the large trade in its valuable bark as a spice, it was, in all probability, exterminated in the middle hill country, and it is only in consequence of its being regularly cultivated now as a product for commercial use that it has survived.

The most largely represented genus is *Litsea*, of which we have 9 species. These are well distributed in the western parts of the Island, extending to our highest altitudes. *Actinodaphne* has no non-indigenous forms, and represents 7 species; the next largest genus being *Cinnamomum* with 4 endemics out of 5 species.

In consideration of the fact that the fruits are freely eaten by birds, it is remarkable that our middle altitudes between 1,600 feet and 3,000 feet appear to have no lauraceous plants.

The *Proteaceae*—natives principally of Australia and the Cape of Good Hope—find a solitary representative in Ceylon in *Helicia zeylanica*, which is endemic here. Its purple-black fruits are probably bird-eaten, but evidence is wanted. Apparently, this isolated type is a survival of a once widely-spread family, that now has become southern only, and which may be replaced by *Grevillea*, that now thrives in a cultivated state.

Of the family *Thymelaeaceae*, in Ceylon, we have 4 genera, and 4 species, of which *Phaleria* and *Gyrinops* supply one endemic each. I

Lauraceae Range	Endemic		Non-endemic	
	Number	%	Number	%
0 to 1,000 ft.	2	8.70	4	40
1,000 to 2,000 ft.	3	13.—	1	10
1,000 ,, 3,000 ft.	2	8.70	1	10
1,000 ,, 4,000 ft.	2	8.70	2	20
1,000 ,, 5,000 ft.			1	10
1,000 ,, 6,000 ft.				
1,000 ,, 7,000 ft. & over				
2,000 ft.				
2,000 to 3 000 ft.				
2,000 ,, 4,000 ft.			1	10
2,000 ,, 5,000 ft.				
2,000 ,, 6.000 ft.				
2,000 ,, 7,000 ft. & over				
3,000 ft.				
3,000 to 4,000 ft.	2	8.70		
3,000 ,, 5,000 ft.				
3,000 ,, 6,000 ft.				
3,000 ,, 7,000 ft. & over	1	4.36		
4,000 ft.	1	4.36		
4,000 to 5,000 ft.				
4,000 ,, 6,000 ft.	3	13.00		
4,000 ,, 7,000 ft. & over	2	8.70		
5,000 ft.	1	4.36		
5,000 to 6,000 ft.				
5,000 ,, 7,000 ft. & over	1	4.36		
6,000 ft.				
6,000 to 7,000 ft. & over	2	8.70		
7,000 ft. & over	1	4.36		
	23	100.00	10	100.00

am unable to say if the fruits are animal-eaten. The whole family is composed of inconspicuous bushes, or small trees, of which the commonest is *Gyrinops Walla*, which occurs in some abundance in our wet forests. As it grows well as a pollard, it is frequently found in Chena lands, especially in damp places.

The *Loranthaceae* have 4 genera, and 25 species, of which no fewer than 10 are endemic. The fruits are attractive, and bird-eaten, but

I have only observed one particular bird—*Dicaeum erythrorhyncum*—that not only eats the fruit, but builds in *Loranthus*. Wait,[3] speaking of this bird, says : " In the forest it also feeds on the berries of jungle creepers." It is widely distributed in Ceylon at, as Mr. Wait says, " all elevations." The very rare *Acmonorhyncus vincens* (Legge's Flower-pecker) is also supposed to spread *Loranthus*, but as I have only once met with the bird, I am unable to confirm this statement. The altitudinal

Loranthus Range	Endemic		Non-endemic	
	Number	%	Number	%
From 0 to 1,000 ft.	2	20	1	6.66
1,000 ,, 2,000 ft.	1	10	2	13.33
1,000 ,, 3,000 ft.	2	20	1	6.66
1,000 ,, 4,000 ft.			3	20.—
1,000 ,, 5,000 ft.			1	6.66
1,000 ,, 6,000 ft.			1	6.66
1,000 ,, 7,000 ft. & over			2	13.34
2,000 ft.	1	10		
2,000 to 3,000 ft.				
2,000 ,, 4,000 ft.				
2,000 ,, 5,000 ft.				
2,000 ,, 6,000 ft.				
2,000 ,, 7,000 ft. & over				
3,000 ft.	1	10	1	6.66
3,000 to 4,000 ft.				
3,000 ,, 5,000 ft.				
3,000 ,, 6,000 ft.	1	10		
3,000 ,, 7,000 ft. & over	1	10	1	6.66
4,000 ft.				
4,000 ,, 5,000 ft.				
4,000 ,, 6,000 ft.				
4,000 ,, 7,000 ft. & over	1	10		
5,000 ft.			1	6.66
5,000 to 6,000 ft.				
5,000 ,, 7,000 ft. & over				
6,000 ft.				
6,000 to 7,000 ft. & over			1	6.66
	10	100.00	15	100.00

distribution of the family, however, is rather significant in the gaps which occur in the endemics and non-endemics alike It is, however, to be observed that the parasite is not equally common on all trees alike, and that there are certain trees on which no plant of this order ever occurs, so that the distribution may be affected, certain trees only being suitable for one particular *Loranthus* and not another.

Again, it may be that scarcity of suitable trees may secure isolation; thus the adoption of *Salvadora* at Mannar, or of old abandoned Tea trees in abandoned land at Dolosbage, may be merely instances where other suitable hosts were inconveniently few. I therefore suppose that the abundance or reverse of examples of this order is very much a matter of circumstance. The apparent increase of *Loranthus* around Bandarawela is probably because there are so few trees there.

The remarkable order *Balanophoraceae* is represented, in Ceylon, by a single genus, with one endemic, and one non-endemic species. I am quite unacquainted with the method of fruit dispersal of these strange plants.

The *Euphorbiaceae* is one of our largest orders, consisting of 43 genera, and 130 species. One genus is monotypic, and 45 species are endemic.

The largest genus is *Phyllanthus*, and it affords the greatest number of endemic forms (9 out of 20), but the fruits in this genus are not all apparently bird-attractive, so that the dispersal is not easily accounted for. Among the minute-fruited forms of this order are several that are water-loving, or adopt very moist surroundings, that may account for seed dispersal by water only. Others again are, probably, entirely geomitridally spread, and have survived after a long but slow natural system of progression, during which variation is conceivable.

Very roughly divided into conspicuous and inconspicuous or unattractive forms of fruit, I find that 56 represent the former, and 74 the latter, but this classification is obviously very incomplete, and liable to much modification, particularly in respect of those with capsular fruits that are coated with hair. How far these may be even the favourite fruits of certain birds appears to be unknown, and till this is more completely worked out, the question of the distribution of the fruit must remain uncertain.

The *Urticaceae* is another largely-represented order. In Ceylon we have 27 genera, and 62 species, but only 8 of these are endemic. *Ficus*, our largest genus in this order, has 21 species, of which 3 are endemic. Five other genera have only one endemic representative in each. Though *Ficus* is our largest genus, the individual species do not occur in any large numbers, even though the fruits are bird (and bat) eaten. In

Artocarpus nobilis we have a fruit that is devoured by man, as well as birds and monkeys. In *Allaeanthus*, however, fruit dispersal is doubtfully bird-carried, and equally so in *Elatostema*. *Pouzolzia* is made up of herbs with unattractive fruits. In *Debregeasia* we have a shrub and an epiphytic plant that bear attractive fruits that are bird-eaten.

It has been stated that the well-known jak fruit tree (*Artocarpus integrifolia*) is a forest tree in Ceylon. This is incorrect. In many places it may be found in rocky forest lands, the seeds having been brought there first by human agency.

The order *Hydrocharitaceae* consists in Ceylon of 7 genera, and 9 species, of which one is endemic. The whole family are fresh, or salt water plants, belonging entirely to the lowest altitude in the Island.

The *Burmanniaceae* consist of 2 genera, and 4 species, of which 2 are endemic. Our endemic forms are the saprophyte *Burmannia Championii*, that I have found growing in rotten bamboo leaves, in the wet forests of Sabaragamuwa, and the rare *Thismia Gardneriana*. I am not acquainted with the fruiting of either of the above.

The great order of *Orchideae*, the third largest in Ceylon, is made up of 61 genera, and 161 species, of which 78 are endemic. Three genera are also peculiar to the country.

I think that it would be unprofitable to make any analysis of distribution in this order, as I am not aware of any very definite data as to how the seed is carried, other than by wind.

We are confronted with other considerations, such as the varying character of the plants themselves in their place of growth, some being content with rock crevices, others on damp soil, stems of trees, moss-grown logs, or even dead stems of forest plants. With such a variety among the hosts as this, it follows that the individual examples possess modifications to adapt them to these complex and unequal surroundings. We have not, as far as I am aware, any data to show why such widespread variation exists in the selection—if that phrase may be used—of one particular form or species of tree to grow on, in preference to another, or a complete chain by which the epiphytic forms of orchids can be traced to the terrestrial, as it appears they must be.

I can not attempt to suggest any particular reason for the large number of endemic forms that this vast order has in Ceylon, especially as I am unacquainted with any detailed data bearing on particular methods of seed distribution in the plants themselves.

The order *Scitamineae* is made up of 14 genera, and 37 species, of which 17 are endemic. One genus is endemic.

It may be worthy of consideration to remark that in the *Orchidaee* the endemic species form 47.82 per cent. of the total species, while we find that in the *Scitamineae* we have 46 per cent.—a rather striking parallel, if not a significant one. The altitudinal distribution of the order is shown in the following table :—

Scitamineae Range	Endemic		Non-endemic	
	Number	%	Number	%
From 0 to 1,000 ft.	7	41.17	4	20
1,000 ,, 2,000 ft.	—	—	6	30
1,000 ,, 3,000 ft.	—	—	4	20
1,000 ,, 4,000 ft.	2	11.76	3	15
1,000 ,, 5,000 ft.	1	5.88	2	10
1,000 ,, 6,000 ft.	—	—	1	5
1,000 ,, 7,000 ft. & over	—	—	—	—
2,000 ft.	1	5.88	—	—
2,000 to 3,000 ft.	—	—	—	—
2,000 ,, 4,000 ft.	1	5.88	—	—
2,000 ,, 5,000 ft.	—	—	—	—
2,000 ,, 6,000 ft.	—	—	—	—
2,000 ,, 7,000 ft. & over	—	—	—	—
3,000 ft.	—	—	—	—
3,000 to 4,000 ft.	3	17.65	—	—
3,000 ,, 5,000 ft.	—	—	—	—
3,000 ,, 6,000 ft.	—	—	—	—
3,000 ,, 7,000 ft. & over	—	—	—	—
4,000 ft.	1	5.88	—	—
4,000 to 5,000 ft.	—	—	—	—
4,000 ,, 6,000 ft.	—	—	—	—
4,000 ,, 7,000 ft. & over	1	5.88	—	—
5,000 ft.	—	—	—	—
5,000 to 6,000 ft.	—	—	—	—
5,000 ,, 7,000 ft. & over	—	—	—	—
6,000 ft.	—	—	—	—
6,000 to 7,000 ft. & over	—	—	—	—
	17	100.00	20	100.00

It will be observed that both our endemic and non-endemic forms are more numerous from 2,500 feet downwards, and that the non-endemic forms scarcely touch those sections that start from 2,000 feet.

They affect damp ground, rocky land, and margins of streams, even in the forests of the dry country. The fruits of some, as in the cardamon, are eaten by monkeys, and probably jungle rats also prey upon them, as I have frequently found cases to support this suspicion. Water-transport is probably the chief means of dispersal, in addition to the geomitridal.

Of the *Dioscoreaceae* Ceylon has 2 genera, and 7 species, of which only one is endemic, viz., *D. intermedia*. This species occurs on both the western and eastern sides of the Island. Its seeds are winged. The non-endemics are not found at high altitudes, and, except cultivated forms, the order is not very abundant. The curious little *Trichopus zeylanica* is locally abundant, and affects damp soils. It's seeds are probably water-carried, while the fruits are frequently eaten by native children.

The *Liliaceae* are well represented in Ceylon, there being 12 genera, and 18 species, of which 2 are endemic. *Asparagus* is the largest genus, and affords one species peculiar to the country, *A. zeylanicus*, that occurs over a wide altitudinal range. The remaining endemic, *Urginea rupicola*, appears to be very rare, and confined to low altitudes. Our most common representatives of this order are non-endemic, and their means of transportation arouses interest, as it is not apparent how this is effected. *Gloriosa superba*, for example, presents the problem of being common by the sea-shore and plentiful, locally, at 2,500 ft. altitude in *forest* land. I have found this plant growing on soil on the top of an isolated rock, and again in deepish damp soil in abandoned chena land. It is notoriously poisonous, but is much eaten by a large caterpillar, especially in the wet-zone. Though much admired by Europeans for the beauty of its flowers, I do not think it is so frequently grown artificially as to account for its presence in isolated places, where I have repeatedly found it.

The *Commelinaceae* include 5 genera, and 30 species, of which 3 are endemic. These are *Commelina Thwaitesii*, *Cyanotis obtusa*, and *C. zeylanica*. The two former are rare : possibly *C. obtusa* (if it is endemic) by its isolation on Doluwa Kanda may be found only to be an environmentally altered form, as the situation of this lonely forest-covered rock appears to influence more than one family of plant, especially as at one time Doluwa Kanda was inhabited, and succulent plants may have been humanly introduced for fodder, if not for human use. *C. zeylanica* is common, and in places is a weed. Stems broken off will grow readily, and as the plant is readily eaten by goats, it is probably spread by them, just as goats have spread *Mimosa pudica*. Coolies on estates frequently carry plants of this order to their " lines," to feed cattle and goats, and

in consequence it is very frequently found that Commelinas are regular estate weeds.

The very important order *Palmaceae* has, in Ceylon, 10 genera, and 21 species, of which we have one endemic genus and a total of 11 endemic species.

In *Areca* we have 2 species, of which *A. concinna* is endemic. It is found, when in a natural state, in fresh-water swamps, locally called " Waturana lands," but only below 1,000 feet altitude. The fruits are bright scarlet, and attractive. *A. Catechu* is cultivated extensively. In certain parts of the wet-zone I have found this species growing wild, but only as " escapes " from abandoned gardens.

The monotypic *Loxococcus* is peculiar in its affection for rocky precipices, where it is generally to be found. On the very edges of some of our highest precipices, it occurs in abundance ; but, while I have found several solitary palms of this species growing in rock crevices, or on brackets of rock, I have failed to find it right at the foot of the same cliffs. The fruits are of a rich red colour, and are eaten by monkeys, but why *L. rupicola* is apparently confined to circumscribed and precipitous spots, I am unable to discover a reason for.

Oncosperma fasciculatum, another endemic palm, to some extent, shares a similar habitat as the last. This species, however, does not always select the edge of a precipice, and is frequently found well in the heart of the forest, growing gregariously on thin crusts of soil. It's stem is provided with large, finely pointed, brittle spines, so that probably it is not visited by monkeys. The fruits are deep purple in colour, and bird-attractive.

Phoenix zeylanica is very abundant at low altitudes, on both sides of the Island. The fruits are small, red, and attractive.

Calamus is our largest genus, and has 7 endemic species, out of a total of 10. All have attractive fruits, and are both bird- and monkey-eaten.

Of our non-endemics, *Corypha*, *Borassus*, and *Cocos*, like *Areca Catechu*, are cultivated, while *Caryota urens* is so much employed by the people, and grows so readily, that it might almost be regarded as a domesticated species. It occurs, however, in a wild state in many of our wet and dry forests. I have found the seeds of this species in the excrement of monkeys, and *Jackals*. *Nipa fruticans* is rare, water-carried, non-endemic. It occurs in the south, and I have also found it in the east, but it is not common.

Our *Pandanaceae* consist of 2 genera, and 5 species, of which 3 are endemic. *Pandanus zeylanicus* occurs in a natural state in the beds of

streams, and is also cultivated. The fruits lend themselves to water-transportation. The locally small genus *Freycinetia* is confined to tree-climbing species, with highly attractive, brilliant coloured carpels. I have obtained *F. Walkeri* from the summit of the monsoon-scourged rock of Kunadiyaparawitta, where I have no doubt it was introduced by birds. It should be noted that, while both *F. pycnophylla* and *F. Walkeri* are both abundant in the wet country and are powerful tree-climbers, they are not to be found ascending all kinds of trees equally; thus, they are not to be found frequently on all Dipterocarps alike, nor have I found them confined to rough-barked trees, so that there appears to be a selective action at work, even in those localities where the genus is plentiful.

The order *Araceae* is composed of 15 genera, and 23 species, of which 14 are endemic. The two largest genera, *Cryptocoryne* and *Lagenandra*, of 5 species each, have 4 endemics apiece.

The family is widely distributed in Ceylon, but except *Pothos* (which is a scandent genus), it is confined to wet or damp places. The fruits are all, or nearly all, attractive, but are more probably water-carried, except in those cases where the plants are climbers. Several species are found, more or less cultivated, in gardens, and have run wild therefrom. In *Pothos*, the fruits are probably all bird-eaten.

The small order *Triurideae* consists of one genus, and 3 species, of which 2 are endemic. I am entirely unacquainted with the family.

The order *Naiadaceae*, according to Trimen, is composed of 5 genera, to which Willis[5] adds *Diplanthera*, which is included by Trimen in *Cymodocea*. There are 11 species, of which only one is endemic, *vide* Willis. The whole order is aquatic, and, excepting *Aponogeton crispum*, is confined to sea-level. *A. crispum* is found in running streams, up to 6,500 feet altitude.

The small order of the *Eriocaulonaceae*, consists of one genus, and 18 species, of which 7, or 38 %, are endemic.

As will be seen from the table opposite, the distribution of our indigenous members of this family, as contrasted with the non-endemics, is remarkable.

The fruits are very small, and membranous, and the seeds extremely minute. Their transportation in mud attached to the feet of wading birds is probable, but so far unauthenticated.

The *Cyperaceae* is one of Ceylon's largest orders, having 22 genera, and 161 species, of which only 12 are endemic. As will be seen by re-

Eriocaulon Range	Endemic		Non-endemic	
	Number	% of whole genus	Number	% of whole genus
1,000 ft.	4	22.22	4	22.22
1,000 to 3,000 ft.	—	—	1	5.55
1,000 ,, 4,000 ft.	—	—	2	11.12
1,000 ,, 5,000 ft.	—	—	—	—
1,000 ,, 6,000 ft.	—	—	—	—
1,000 ,, 7,000 ft. & over	—	—	—	—
2,000 ft.	—	—	—	—
2,000 to 3,000 ft.	—	—	—	—
2,000 ,, 4,000 ft.	—	—	—	—
2,000 ,, 5,000 ft.	—	—	—	—
2,000 ,, 6,000 ft.	—	—	—	—
2,000 ,, 7,000 ft. & over	—	—	—	—
3,000 ft.	—	—	—	—
3,000 to 4,000 ft.	—	—	—	—
3,000 ,, 5,000 ft.	—	—	—	—
3,000 ,, 6,000 ft.	—	—	1	5.55
3,000 ,, 7,000 ft. & over	—	—	1	5.55
4,000 ft.	—	—	—	—
4,000 to 5,000 ft.	—	—	—	—
4,000 ,, 6,000 ft.	—	—	1	5.55
4,000 ,, 7,000 ft. & over	—	—	—	—
5,000 ft.	—	—	—	—
5,000 to 6,000 ft.	—	—	—	—
5,000 ,, 7,000 ft. & over	2	11.12	1	5.55
6,000 ft. & over	1	5.55	—	—

ference to the tables of distribution, few reach our high altitudes, *Carex lobulirostris* being the only species to reach 7,000 feet and over. It will be noticed that our total number of endemic cyperaceous plants only amounts to 7.45 % the whole order ; while of the genera, 27.25 % have endemic representatives.

Dividing the order into endemic and non-endemic branches, the altitudinal distribution is thus analysed:—

Range.	*Cyperaceae.* Endemic.		Non-endemic.		*Gramineae.* Endemic.		Non-endemic.	
	No.	%	No.	%	No.	%	No.	%
1,000 ft.	5	41.66	64	42.95	9	29.03	82	39.61
1,000 to 2,000 ft.	—	—	9	6.34	1	3.23	31	15.—
1,000 ,, 3,000 ft.	1	8.33	22	14.76	—	—	13	6.28
1,000 ,, 4,000 ft.	—	—	9	6.04	—	—	20	9.66
1,000 ,, 5,000 ft.	—	—	4	2.68	1	3.23	2	.96
1,000 ,, 6,000 ft.	—	—	5	3.35	—	—	3	1.45
1,000 ,, 7,000 ft. & over	—	—	4	2.68	—	—	11	5.31
2,000 ft.	—	—	—	—	1	3.23	—	—
2,000 to 3,000 ft.	—	—	1	.67	—	—	2	.96
2,000 ,, 4,000 ft.	—	—	—	—	2	6.45	8	3.86
2,000 ,, 5,000 ft.	—	—	—	—	—	—	1	.48
2,000 ,, 6,000 ft.	—	—	2	1.34	—	—	4	1.93
2,000 ,, 7,000 ft. & over	—	—	1	.67	—	—	3	1.45
3,000 ft.	2	16.66	—	—	1	3.23	2	.96
3,000 to 4,000 ft.	—	—	1	.67	1	3.23	3	1.45
3,000 ,, 5,000 ft.	1	8.33	2	1.34	1	3.23	1	.45
3,000 ,, 6,000 ft.	—	—	1	.67	—	—	1	.48
3,000 ,, 7,000 ft. & over	—	—	1	.67	—	—	2	.96
4,000 ft.	—	—	2	1.34	1	3.23	—	—
4,000 to 5,000 ft.	—	—	1	.67	—	—	1	.48
4,000 ,, 6,000 ft.	1	8.33	3	2.02	3	9.67	2	.96
4,000 ,, 7,000 ft. & over	—	—	11	7.38	—	—	8	3.86
5,000 ft.	—	—	—	—	2	6.45	2	.96
5,000 to 6,000 ft.	—	—	1	.67	2	6.45	—	—
5,000 ,, 7,000 ft. & over	1	8.33	3	2.02	1	3.23	1	.48
6,000 ft.	1	8.33	—	—	2	6.45	—	—
6,000 ,, 7,000 ft. & over	—	—	2	1.32	2	6.45	3	1.45
7,000 ft.	—	—			1	3.23	1	.48
	12	100.00	149	100.00	31	100.00	200	100.00

I had the unique opportunity of observing the first forms of vegetation in the bed of a tank that had burst, after being full of water for about 60 years.

This was the Haliella Tank, in the Matara District. The entire watershed of the tank did not extend above 1,000 feet altitude, and mostly from forest-clad land, so that the plant forms could only be expected to come from a correspondingly low level. The tank itself covered approximately 400 acres, and at no place did the depth of water exceed 50 feet, so that in section it formed a narrow wedge longitudinally, and two narrow wedges, back to back, if taken transversely. I paid a number of visits to the tank in order to observe the first forms of vegetation, and their relative density.

By far the largest number were *Cyperaceae*. The second most abundant were two species of *Cassia*, followed by scrophulariaceous plants. All the large-fruited plants were absent, though I collected several decomposed examples. Later, composites formed along the wet or moist edges of the hollows, but these, I consider, were late arrivals, and wind-carried.

Unfortunately, my notes were all destroyed, white ants having devoured my note-book, so I am unable to record, in detail, the particulars of the individual species examined and tabulated at the time. However, the facts go to show that the survivors, after a long period of total saturation, were only those that had hard horny seeds, and that undoubtedly these were water-carried. The inference to be drawn is rather important, and possibly bears on the large percentage of hard-seed bearing plants being found crowding the banks of rivers in the low-country, and the beds of non-perennial streams in the dry-zone. It will be observed that, in our Ceylonese *Cyperaceae*, by far the highest number of endemics and non-endemics alike belong to the lowest strata of altitude.

The *Gramineae* is our largest order in Ceylon, and is made up of 83 genera, and 240 species, of which 31 are peculiar to the Island. These 31 endemics are distributed over 19 genera, but no one genus is confined to this country. It will be noticed that, while the genera are exceedingly numerous, they only average about 3 species in each.

I have placed alongside of the table of *Cyperaceae* the corresponding figures to show the altitudinal distribution of the grasses, but I regret that I cannot accept the data there given with full confidence, as there is much room for supposing that a new revision of our Ceylon grasses is desirable, the material on which Sir J. D. Hooker compiled his work being incomplete.

Faulty though these figures may be, they show that our grasses have a remarkable diversity of distribution, but, as already referred to, this is entirely governed by the diversity of our Patana and Talawa lands. The extent to which man has played a part in the distribution of grasses probably can not be estimated, but the fact that grasses play a most important part in his domestic economy, directly and indirectly, can not be overlooked

Finally, the dispersal by birds and animals supplements the method of dissemination. It is more than probable that many birds, in constructing their nests, transport grass that is in seed at the time, and in this way introduce a few individuals that afterwards spread. It is not necessary to detail the number that are wind and water-carried, as this is sufficiently well-known.

With the *Gramineae* I close my list of Ceylon plants, and their endemic distribution.

It will be seen that out of a total of 149 orders, 89, or 59%, have endemic species, and it is of these endemics that I have detailed a table to show their individual distribution, as far as I am able to discover from the material at hand.

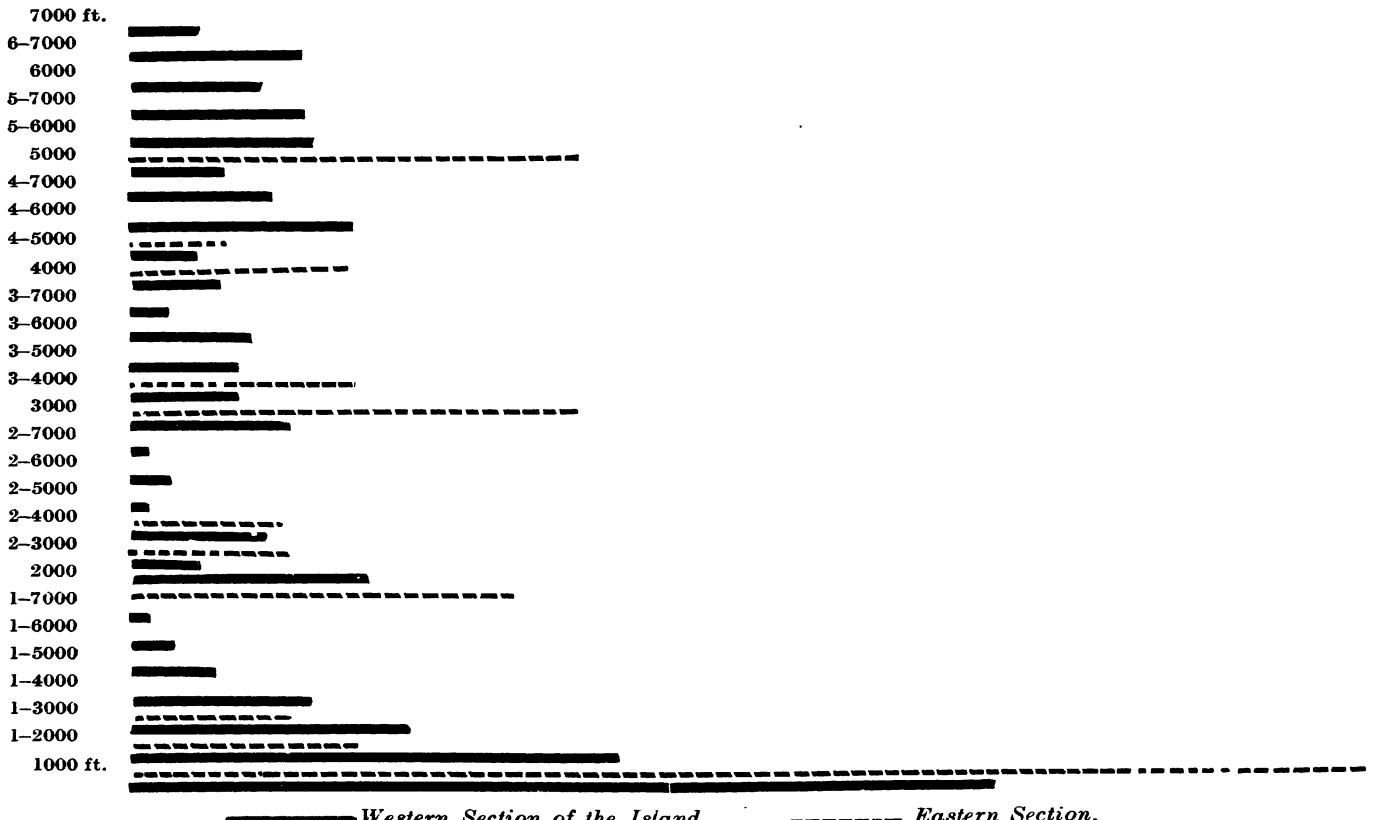
Classified into numbers having specific altitudinal distribution, the following table will be found helpful:—

Of the total of 804 recorded endemics, I have deducted 17, as either having insufficient material to establish identity, or in some cases where locality is not recorded. Where an endemic is found on both sides of the Island it will be included in the western aspect only, and a * showed as indicating western, as well as eastern, where no examples specially occur in the eastern side alone.

Range.	Western aspect.		Eastern aspect.	
	Number	%	Number	%
1,000 ft.	195	27.04	32	48.48
1,000 to 2,000 ft.	85	11.80	3	4.54
1,000 ,, 3,000 ft.	41	5.68	2	3.03
1,000 ,, 4,000 ft.	26	3.61	*	—
1,000 ,, 5,000 ft.	12	1.67	—	—
1,000 ,, 6,000 ft.	6	.83	*	—
1,000 ,, 7,000 ft. & over	3	.42	—	—
2,000 ft.	36	5.00	5	7.60
2,000 to 3,000 ft.	11	1.52	2	3.03
2,000 ,, 4,000 ft.	21	2.91	2	3.03
2,000 ,, 5,000 ft.	2	.27	—	—
2,000 ,, 6,000 ft.	6	.84	—	—
2,000 ,, 7,000 ft. & over	2	.27	—	—
3,000 ft.	23	3.19	7	10.62
3,000 to 4,000 ft.	15	2.08	3	4.54
3,000 ,, 5,000 ft.	15	2.08	*	—
3,000 ,, 6,000 ft.	18	2.50	—	—
3,000 ,, 7,000 ft. & over	5	.69	—	—
4,000 ft.	13	1.80	3	4.54
4,000 to 5,000 ft.	9	1.25	1	1.51
4,000 ,, 6,000 ft.	34	4.71	*	—
4,000 ,, 7,000 ft. & over	21	2.91	—	—
5,000 ft.	14	1.94	6	9.10
5,000 to 6,000 ft.	28	3.88	*	—
5,000 ,, 7,000 ft. & over	25	3.46	—	—
,, 6,000 ft.	19	2.63	*	—
6,000 ,, 7,000 ft. & over	26	3.63	—	—
7,000 ft. & over	10	1.39	—	—
	721	100.00	66	100.00

This table, when expressed in the form of a graph, conveys the above figures in a more striking form.

Graph illustrating the percentage of Endemics at different altitudes, and for both Sections of the Island.



The table and the graph both illustrate the percentage of our endemics at certain definite altitudes, and they show more or less strikingly, that the greater number of endemics are to be found at the foot of the hills, instead of at our highest altitudes. It suggests itself that this is explained by gravitational action, by which streams carry down seeds, or fruits, that in turn over-populate the lower levels, and in so doing set up a larger struggle for existence ; and by the operation of the law of natural selection, the strugglers develop latent forces, that in turn become specifically divergent, and consequently evolve a type, so modified as not only to survive, but to constitute a distinct form. This " form," owing to its divergence, we class as a distinct or endemic species.

Had the struggle not been so intense, it is probable that the necessity for divergence would not have existed, and " new species " would have been fewer. But the stage would arise (provided extraneous influences of an unforeseen nature were absent). when the " new species " would war against other " new species," till by the same process a " more fit " was developed, that would persist at the expense of *its* surroundings. No dynamical law could be laid down by which we could determine the *time* required for one series to dominate a second, to the extermination of the last. Not only does the personal or individual equation come in, but the presumption must arise as to the individual's tenacity, vitality, or degree of immunity from disease, that might even cause extinction.

The problem is beset with other influences, such as soil, or climate, or that ever-variable source of danger—man. Man has brought fire and the axe—two of the most disruptive forces in plant life. No better illustration of this could be found in this country than by comparing a "virgin forest," with a "chena land" that has been abandoned for 15 or 20 years. The difference produced, though natural in its result, is the outcome of an artificial partial destruction. To bring back the "chena" to the original conditions before the land was " chenaed," would probably be impossible, but it could hardly be contended that this impossibility of reconstruction is due to a spontaneous generation of new species. The changed conditions might conceivably produce a retroversion to a form that had once existed, but which, through environmental pressure, had long since changed its form or habit, till this sudden liberation by the accident of man's interference.

The presence of a form on the two sides of a vast valley, identical in appearance, may be occasioned by the simultaneous departure in opposite directions of an organism capable of reproducing itself without the aid of adventitious agents of transportation. Such a progression (which I have ventured to call geomitridal), would be obviously slower

than if the fruit, or seed, was carried by some bird or beast ; but it is probable, that, in the course of its pilgrimage, a much more elaborate modification would be evolved, making the divergence from the original stock so marked, as practically to cut itself away completely from recognition as having been once the same thing, as we recognise it under another name at its place of primary incidence.

I have not attempted to bring to bear upon my subject the " rarity," or otherwise, of a plant. This " rarity " may be accounted for in other ways, and is not, I think, a safe guide by which to assume a special importance. Till we can have a mathematical knowledge of the number of plants we have in a country of one kind, as compared with that of another, we can only assume that " rarity " depends more on individual success in collecting than what the actual word implies. If we accept " rarity " as meaning a ratio, we must have the actual factors before we can get at that ratio, so that the expression cannot, as it stands, do more than express an indefinite ratio of commonness, and therefore no certain index of the actual state of affairs. Again, " rare " may mean as regards the country as a whole, though within a circumscribed area the individual may be exceedingly common.

Till our explorations are more complete and systematic, I venture to think that no specific value can be attached, except in a general sense, to the word " rare," and for that reason, where I have used it, I do so with reservation.

I have drawn my deductions from such material as I have at hand, and I must leave it to conjecture if our distribution of endemics is based on correct grounds or not. In advancing the following table, therefore, I am guided entirely by the recorded instances, showing the species collected, and where from ; and this data will doubtless be amplified, or modified, as more material becomes available.

The marginal notes are included as bearing (1) on special colouring of fruits ; (2) rarity ; (3) perfection or imperfection of material on which the species is locally described.

The figures in the vertical columns indicate the altitude at which the material has been obtained.

TABLE OF CEYLON ENDEMIC PLANTS, SHOWING ALTITUDINAL DISTRIBUTIC

(Endemic Genera in Capitals)

Orders	Genus	Species
o. 1 **Ranunculaceae.**	*Ranunculus*	*sagittifolius*
2 **Dilleniaceae.**	*Acrotrema*	*uniflorum*
		intermedium
		lanceolatum
		Gardneri
		Thwaitesii
		dissectum
		lyratum
	SCHUMCHERIA	*castaneaefolia*
		alnifolia
		angustifolia
	Wormia	*triquetra*
	Dillenia	*retusa*
3 **Magnoliaceae.** No endemics		
4 **Anonaceae.**	*Uvaria*	*sphenocarpa*
		macropoda
	Unona	*elegans*
		zeylanica
	Polyalthia	*Mooni*
		persicifolia

TABLE OF CEYLON ENDEMIC PLANTS, SHOWING ALTITUDINAL DISTRIBUTI(

(Endemic Genera in Capitals)

Fruit.	Western.							Eastern.							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Achenes						×	×								
do		×	×	×											
do	×	×													Rare
do		×	?	?	×										Rare
do			×												
do		×													Very rare
do		×													Very rare
do		×													Very rare
do	×														
do				×	×										
do	×														Rare
Fleshy	×	×	×	×	×										
do	×	×							×						
do	×	×						×							
do		×													Brilliant fruits
do	×								×						
do		×													Scarlet fruits
do	×														Red fruits
do	×														

Orders	Genus	Species
No. 4 **Anonaceae.** (*Contd.*)	*Xylopia*	*parvifolia*
		nigricans
		Championii
	Goniothalamus	*Gardneri*
		Hookeri
		Walkeri
		Thomsoni
		reticulatus
		salicinus
	Bocagea	*Thwaitesii*
		obliqua
		coriacea
	Miliusa	*zeylanica*
	Alphonsea	*sclerocarpa*
5 **Menispermaceae.** No endemics		
6 **Berberideae.** do		
7 **Nymphaeaceae.** do		
8 **Cruciferae.** do		
9 **Capparideae.** do		
10 **Violaceae.**	*Ionidium*	*ramosissimum*
	Alsodeia	*virgata*
11 **Bixaceae.**	*Scolopia*	*crassipes*
		Gaertneri
	Erythrospermum	*phytolaccoides*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy	×										×				
do	×									×					Rare
do	×	×													
do		×													
do		×													
do	×														Very rare
	×														Very rare
do	×														Very rare
do	×	×	×	×	×										
do	×	×	×	×											
do	×														Pinkish red fruit
					×	×									
	×														Hard bony fruit
Ovoid								×							Very rare
Dry capsule								×	×						Very rare
Globose	×							×							
Fleshy berry			×	×	×										
do	×							×							
Spherical	×														Scarlet arils

Orders		Genus	Species
No.11 **Bixaceae.** (*Contd.*)		*Aberia*	*Gardneri*
		TRICHADENIA	*zeylanica*
		Hydnocarpus	*venenata*
			octandra
12 **Pittosporaceae.**		*Pittosporum*	*zeylanicum*
13 **Polygalaceae.**		*Polygala*	*glaucoides*
		Salomonia	*cordata*
14 **Caryophyllaceae.**		*Stellaria*	*drymarioides*
15 **Portulacaceae.**	No endemics		
16 **Tamariscineae.**	do		
17 **Elatineae.**	do		
18 **Hypericaceae.**	do		
19 **Guttiferae.**		*Garcinia*	*echinocarpa*
			terpnophylla
		Calophyllum	*Burmanni*
			bracteatum
			Thwaitesii
			trapezifolium
			cuneifolium
			cordato-oblongum
			Walkeri

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Globular		×	×												
Berry	×														
do	×	×						×	×						Water-carried
Globose	×							×							
Capsule		×	×	×	×	×					×	×			Red testa, pulpy
	×														Common in open land
	×														On wet ground
do					×										(Once found only!)
Spinous				×	×	×						×	×		Economic
Ovoid	×	×	×												
do	×							×							Bright red fruit
do	×														
do	×	×	×	×											
Globular											×	×			Rare
										×					Very rare
do	×														Very rare
do					×	×	×						×		Swampy land

Orders	Genus	Species
No.19 **Guttiferae.** (*Contd.*)	*Kayea*	*stylosa*
	Mesua	*Thwaitesii*
20 **Ternstroemiaceae.**	*Ternstroemia*	*emarginata*
	Adinandra	*lasiopetala*
	Gordonia	*zeylanica*
		speciosa
21 **Dipterocarpaceae.**	*Dipterocarpus*	*hispidus*
		zeylanicus
		scabridus
		glandulosus
	Shorea	*oblongifolia*
		Dyeri
		reticulata
		stipularis
	DOONA	*zeylanica*
		affinis
		Gardneri
		nervosa
		trapezifolia
		congestifolia
		cordifolia

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Spherical	×														Very rare
Sub-globose	×														Water-loving
Ovoid					×	×									Water-loving
Fleshy					×	×									
Capsule					×	×	×						×		Seed-winged
				×											Seed-winged
Winged	×														
do	×	×	×								×				
do	×														Very rare
do	×	×													
do	×														
do		×													Doubtful location
do			×												Material wanted
do	×	×													
do		×	×	×											
do		×													
do			×	×	×										
do	×														
do	×	×													
do	×	×													
do	×										×				

Orders	Genus	Species
No.21 **Dipterocarpaceae.** (*Contd.*)	DOONA	*ovalifolia*
		oblonga
		venulosa
		macrophylla
	Hopea	*discolor*
		jucunda
		cordifolia
	Sunaptea	*scabriuscula*
		disticha
	Vatica	*affinis*
		obscura
	Balanocarpus	*zeylanicus*
	Vateria	*acuminata*
	STEMONOPORUS	*Wightii*
		Gardneri
		acuminata
		lanceolatuus
		affinis
		rigidus
		caniculatus
		petiolaris

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	
Winged	×												
do	×												
													Material wanted
do	×												
do		×											
do	×												Water-loving
do							×						do rare
do	×												Rare
do	×												Material wanted
Ovoid	×												Water-loving
do							×						Gregarious by streams
do							×						Confined to Dolowakanda
Spongy	×	×											Common near water
Ovoid	×												
Ovoid					×								
Globular							×						
Globose			×										Very rare
do					×						×		
													Very rare
Globular	×												
?	×												Very rare

Orders		Genus	Species
No.25 **Linaceae.** (*Contd.*)		*Erythroxylon*	*acuminatum*
			obtusifolium
26 **Malpighiaceae.**	No endemics		
27 **Zygophyllaceae.**	do		
28 **Geraniaceae.**		*Biophytum*	*nervifolium*
			nudum
			proliferum
		Impatiens	*glandulifera*
			macrophylla
			repens
			leptopoda
			truncata
			janthina
			Hookeriana
			subcordata
			leucantha
			linearis
			appendiculata
			elongata
			cornigera
			Arnottii

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Drupe	×							×							
do	×	×	×							×					Scarlet fruit
Capsule								×							
do				×	×	×									
do					×	×	×								
do				×	×	×									
do				×	×	×	×								
do	×	×								×					
do						×									
do					×	×	×								
do	×	×													Very rare
do		×		×	×	×				×					
do				×	×	×									
do	×														Very rare
do			×												
do	×	×	×	×	×										
do				×	×										Very rare
do	×														
do	×	×	×												

Orders		Genus	Species
No.28 **Geraniaceae,** (*Contd.*)		*Impatiens*	*Walkeri*
29 **Rutaceae.**		*Glycosmis*	*bilocularis*
		Murraya	*Gleniei*
30 **Simarubaceae.**	No endemics		
31 **Ochnaceae.**		*Ochna*	*rufescens*
32 **Burseraceae.**		*Canarium*	*brunneum*
			zeylanicum
33 **Meliaceae.**		*Munronia*	*pumila*
		Aglaia	*apiocarpa*
		PSEUDOCARAPA	*Championii*
		Walsura	*Gardneri*
34 **Chailletiaceae.**	No endemics		
35 **Olacineae.**		*Olax*	*zeylanica*
		Apodytes	*Gardneriana*
36 **Ilicineae.**			
37 **Celastraceae.**		*Euonymus*	*revolutus*
			Thwaitesii
			Walkeri
		Microtropis	*Wallichiana*
		Gymnosporia	*fruticosa*
		Kurrima	*zeylanica*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Capsule				×	×	×									Rare
Berry								×							Very rare
do								×							
Carp.	×														Very rare
Ovoid, hard	×	×													
Oblong ovoid	×	×						×							
Dry capsule								×							Medicinal
Fleshy			×	×	×						×				
Globose	×	×	×	×											Red arils
Ovoid		×	×							×					White arils
Drupe	×									×					Scarlet fruit
Compressed drupe					×	×									
Capsule						×	×								
do		×													Coloured aril
do	×	×	×	×	×	×						×	×		Coloured aril
do			×	×	×	×				×					
Minute		×													Crimson seed. Very rare
Fleshy	×	×	×	×				×							Fleshy sweet aril

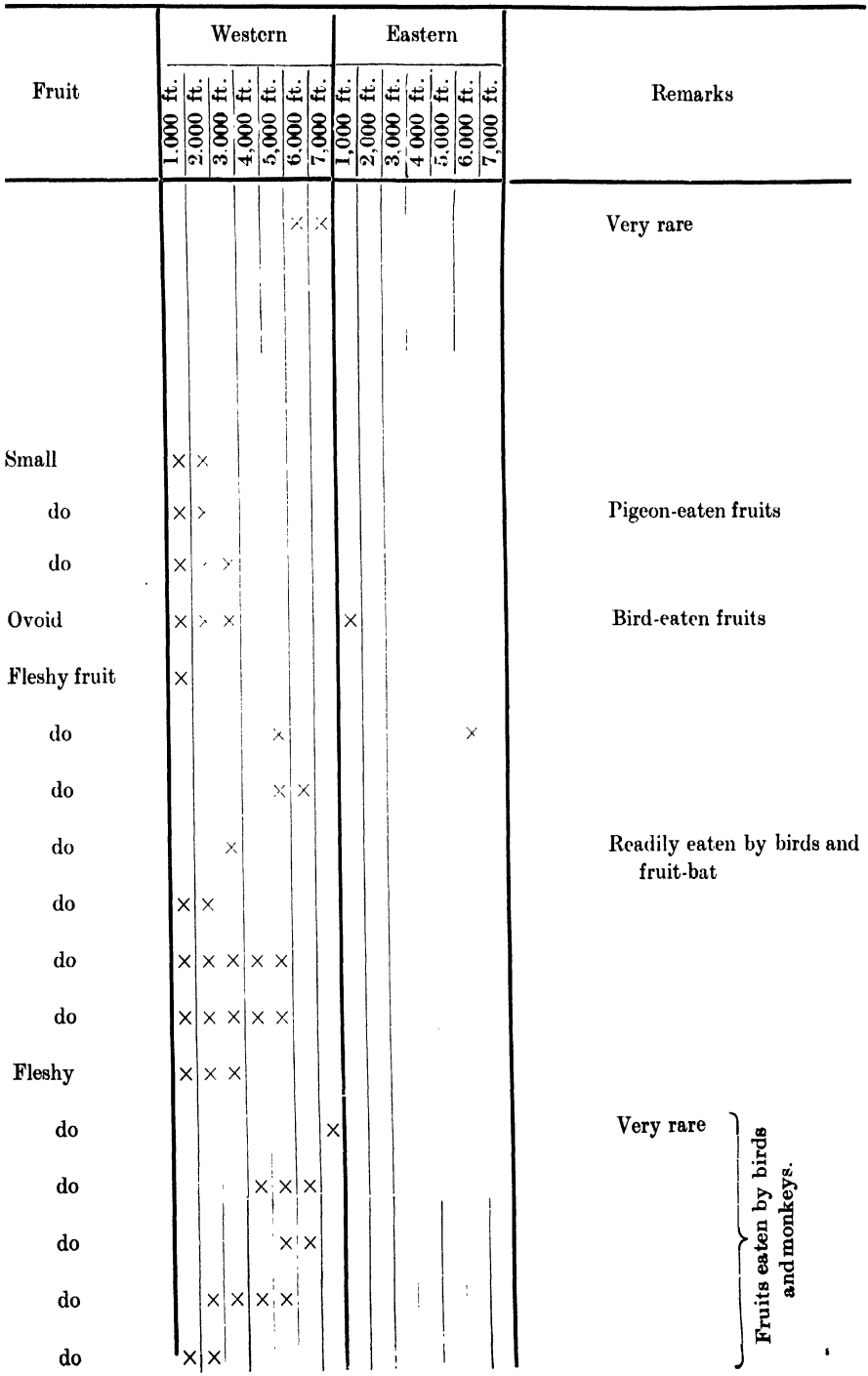
	Orders		Genus	Species
No. 38	**Rhamnaceae.**		*Zizyphus*	*napeca*
			Rhamnus	*Arnottianus*
39	**Ampelideae.**		*Vitis*	*glyptocarpa*
				lonchiphylla
				acuminata
				Gardneri
				reticulata
40	**Sapindaceae.**		*Allophylus*	*hispidus*
			GLENIEA	*zeylanica*
			Sapindus	*erectus*
				Thwaitesii
41	**Sabiaceae.**	No endemics		
42	**Anacardiaceae.**		*Mangifera*	*zeylanica*
			Semecarpus	*marginata*
				subpeltata
				pubescens
				obovata
				Moonii
				coriacea
				Walkeri
				Gardneri

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy	×														
do						×	×								
Succulent	×	×						×							
do	×														
do	×							×							
do			×	×	×	×				×	×	×			Purple fruits
do	×														Pink fruits
Ovoid	×														Red fruits
Fleshy	×							×							Sweet fruits
do	×	×													
?	×														Very rare
Fleshy	×	×						×	×						Man, monkey, and bird-eaten
Fleshy recept	×	×	×												
do	×														
do	×														Very rare
do	×														
do	×														Very rare
do				×	×	×					×				
do	×	×													
do	×	×													

Orders	Genus	Species
No.42 **Anacardiaceae.** (*Contd.*)	*Semecarpus*	*acuminata*
		nigroviridis
		obscura
		parvifolia
		laevigata
	Campnosperma	*zeylanicum*
43 **Connaraceae.**	*Connarus*	*Championii*
	Ellipanthus	*Thwaitesii*
44 **Leguminosae.**	*Crotalaria*	*multiflora*
		Walkeri
	Desmodium	*jucundum*
	Derris	*paniculata*
		parviflora
	Sophora	*violacea*
		zeylanica
	PERICOPSIS	*Mooniana*
	Dialium	*ovoidium*
	Crudia	*zeylanica*
	Pithecolobium	*geminatum*
45 **Rosaceae.**	*Pygeum*	*zeylanicum*
	Agrimonia	*zeylanica*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy recept	×														Very rare
do			×	×	×	×									
do		×						×	×						
do	×														Very rare
do															Material wanted
Pulpy	×	×													Gregarious habits
Fleshy aril	×	×	×	×				×							Aril coloured
do		×	×							×					Pink aril
Dry pod				×	×	×									Patina plant
do				×	×										
do										×					Very rare
do									×						Very rare
		×						×							
Pod	×							×							Very rare
do				×	×	×	×			×					
do	×														Water-loving
Sweet								×							Man and monkey-eaten
	×														Very rare
Pod								×							
	×														
				×	×	×	×								

Orders		Genus	Species
No.45	**Rosaceae.** (*Contd.*)	*Poterium*	*indicum*
46	**Saxifragaceae.**	No endemics	
47	**Crassulaceae.**	do	
48	**Droseraceae.**	do	
49	**Haloragiaceae.**	do	
50	**Rhizophoraceae.**	*Serpicula*	*zeylanica*
		Carallia	*calycina*
		Anisophyllea	*zeylanica*
51	**Combretaceae.**	*Terminalia*	*parviflora*
52	**Myrtaceae.**	*Eugenia*	*cylindrica*
			Fergusoni
			subavenis
			micrantha
			sylvestris
			assimilis
			cordifolia
			Neesiana
			cyclophylla
			rotundifolia
			sclerophylla
			oligantha
			olivifolia


Fruit
Western
Eastern
1,000 ft.
2,000 ft.
3,000 ft.
4,000 ft.
5,000 ft.
6,000 ft.
7,000 ft.
Remarks
Very rare
Small
do
do
Ovoid
Fleshy fruit
do
do
do
do
do
do
Fleshy
do
do
do
do
do
Pigeon-eaten fruits
Bird-eaten fruits
Readily eaten by birds and fruit-bat
Very rare
Fruits eaten by birds and monkeys.

Orders	Genus	Species
No.52 **Myrtaceae.** (*Contd.*)	*Eugenia*	*Haeckeliana*
		terpnophylla
		xanthocarpa
		rufo-fulva
		phillyraeoides
		flocifera
		rivulorum
		fulva
		insignis
		decora
		rotundata
		Mabaeoides
		aprica
		amoena
		pedunculata
		Thwaitesii
	Barringtonia	*zeylanica*
53 **Melastomaceae.**	*Osbeckia*	*Rheedii*
		Walkeri
		buxifolia
		rubicunda

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy	×														Very rare
do	×	×	×												Rare
do	×														Very rare
do	×														Rare
do											×				Very rare
do	×														Very rare
do	×														Very rare
do	×														Very rare
do	×														Very rare
do	×														Very rare
do		×													Scarlet fruit
			×	×	×	×									
											×				Very rare
?	×	×													Very rare
?															
Fleshy		×										×			Crimson fruit
Large, leathery	×														
Small, round						×	×								Water-loving
do						×	×								
do							×								Water-loving
do					×	×	×								

Fruits eaten by birds and monkeys.

Orders	Genus	Species
No.53 **Melastomaceae.** (*Contd.*)	*Osbeckia*	*Moonii*
	Sonerila	*zeylanica*
		rhombifolia
		Wightiana
		hirsutula
		Gardneri
		robusta
		lanceolata
		pilosula
	Medinilla	*fuchsioides*
		maculata
	Memecylon	*Arnottianum*
		Gardneri
		Hookeri
		parvifolium
		varians
		elongatalum
		ellipticum
		macrophyllum
		ovoideum
		revolutum

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Small, round	×														Rare
Capsule		×	×	×	×										
do	×	×	×												
do						×									Rare
do						×	×								Rare
do					×										Very rare
do							×								Very rare
do	×	×													
do		×													Very rare
Soft							×								Epiphytic
do			×	×						×					Epiphytic
Berry	×														
do	×	×	×	×											Purplish fruit
do		×													do rare
do			×	×											Black fruit
do			×	×											
do		×													Purple. Very rare
do	×														
do	×														
do			×	×											Purple fruit. Very rare
do					×										Purple fruit. Very rare

Eaten by many kinds of birds.

Orders		Genus	Species
No.53 **Melastomaceae.** (*Contd.*)		*Memecylon*	*orbiculare*
			procerum
			cuneatum
			Clarkeanum
			fuscescens
			rostratum
			phyllanthifolium
			rhinophyllum
			leucanthum
			macrocarpum
			capitellatum
54 **Lythraceae.**		*Axinandra*	*zeylanica*
55 **Onagraceae.**	No endemics		
56 **Samydaceae.**		*Casearia*	*coriacea*
		Osmelia	*Gardneri*
57 **Passifloraceae.**	No endemics		
58 **Cucurbitaceae.**		*Trichosanthes*	*integrifolia*
		Momordica	*denudata*
		Melothria	*zeylanica*
59 **Begoniaceae.**		*Begonia*	*tenera*
			Thwaitesii

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Berry		×													Small fruit. Very rare.
do	×														Small fruit, rare
do		×													Rare
do		×	×	×											Rare Yellow fruit
do	×														
do			×	×							×	×			
do					×										Very small fruit. Very rare
do	×	×	×												Purple fruit
do			×	×											
do			×												
do	×							×							Purple fruit
Rather large	×	×													Pinkish fruits
Fleshy aril					×	×	×								Rare
do		×	×												
Fleshy		×													Brilliant fruits
do		×	×												
do			×	×	×	×									
Spongy do	×														Acid, insect-eaten
Spongy do			×	×							×				do rare

Eaten by many kinds of birds.

	Orders		Genus	Species
No. 60	**Datiscaceae.**	No endemics		
61	**Cactaceae.**	do		
62	**Ficoideae.**	do		
63	**Umbelliferae.**		*Peucedanum*	*zeylanicum*
			Heracleum	*zeylanicum*
64	**Araliaceae.**		*Heptapleurum*	*emarginatum*
65	**Cornaceae.**		*Alangium*	*glandulosum*
			Mastixia	*tetrandra*
66	**Caprifoliaceae.**	No endemics		
67	**Rubiaceae.**		*Nauclea*	*zeylanica*
			Neurocalyx	*zeylanicus*
				Gardneri
				Championii
			Alloeophania	*decipiens*
			Hedyotis	*evenia*
				eymosa
				Macraei
				obscura
				coprosmoides
				membranacea
				Thwaitesii

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Minute							×								Very rare
do						×									
Small, pulpy		×	×	×											
Fleshy		×	×	×	×	×									Coloured fruit
do		×	×	×											
Massed		×	×	×						×					Rare
Dry	×	×	×	×	×										
	×														Very rare
	×	×													
Small capsule			×	×	×	×	×								
Small					×	×									Very rare
Minute	×														Very rare
															Material wanted
do					×	×	×					×			
do						×	×								
?	×														
Minute	×	×	×	×	×	×									Rare

Orders	Genus	Species
No.67 **Rubiaceae.** (*Contd.*)	*Hedyotis*	*nodulosa*
		cinereo-viridis
		rhinophylla
		Lessertiana
		quinquenervia
		Gardneri
		Lawsoniae
		inamoena
		cyanescens
	Anotis	*numularia*
		numulariformis
		Richardiana
	Ophiorrhiza	*radicans*
		pallida
		glechomifolia
	Acranthera	*zeylanica*
	LEUCOCODON	*reticulatum*
	Urophyllum	*ellipticum*
		zeylanicum
	SCHIZOSTIGMA	*hirsutum*
	Byrsophyllum	*ellipticum*

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	
Minute				×	×	×							
?							×						Rare
Capsule										×			Very rare
do				×	×								
do						×							Very rare
do					×								Rare
do				×	×								
do		×											Very rare
do	×												Very rare
do			×	×	×								
do					×								
do					×	×							
do	×	×	×										
do		×											Very rare
do	×	×	×										
Fleshy		×	×	×						×	×		
do			×	×	×								
do	×	×	×	×	×	×							
do					×	×	×	×					
do		×	×										In very wet (rain) localities
Berry	×												Very rare

Orders	Genus	Species
No.67 **Rubiaceae.** (*Contd.*)	*Randia*	*Gardneri*
	NARGEDIA	*macrocarpa*
	SCYPHOSTACHYS	*pedunculata*
		coffaeoides
	Diplospora	*Dalzellii*
		erythrospora
	Dichilanthe	*zeylanica*
	Knoxia	*zeylanica*
		platycarpa
	Canthium	*montanum*
		puberulum
		macrocarpum
		campanulatum
	Ixora	*calycina*
		Thwaitesii
		jucunda
	Pavetta	*angustifolia*
		Gleniei
		involucrata
	Psychotria	*stenophylla*
		glandulifera

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy	×	×													
Berry	×	×													Very rare
do	×														Very rare
do	×														Rare
do								×							
do				×	×										Very rare
?			×												Very rare
Dry	×	×													In waste and open spaces
do					×	×									In patina lands
Drupe				×	×	×	×								
															Material wanted
do			×												Very rare
do		×	×							×					Very rare
Ovoid				×	×	×	×								
Globose	×	×						×	×						
do	×	×	×												
do	×														Water-loving
do	×							×							
					×	×									
Fleshy	×	×													Bright purple fruits
do						×									

Orders	Genus	Species
No.67 **Rubiaceae.** (*Contd.*)	*Psychotria*	*Gardneri*
		Wrightiana
		Mooniana
		sordida
		longipetiolata
		plurivenia
		filipes
	Lasianthus	*Moonii*
		Thwaitesii
		rhinophyllus
		Walkerianus
		Gardneri
		oliganthus
		obliquus
		strigosus
		varians
	Saprosma	*scabridus*
68 **Valerianaceae.**	*Valeriana*	*Moonii*
69 **Dipsacaceae.**	*Dipsacus*	*Walkeri*
70 **Compositae,**	*Vernonia*	*Gardneri*
		Thwaitesii

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy		×	×												
do	×														Water-loving
do	×														Rare
do					×	×									
do				×	×										Very rare
do			×	×											Very rare
do		×	×	×											Rare
Berry	×	×	×												
do			×												Very rare
?			×			×									Very rare
Berry	×	×	×	×											Water-loving
do				×	×	×									
Small berry	×	×	×												
Berry	×	×	×												
do	×	×	×	×						×	×	×			
do					×	×	×								
do	×														Rare. Material wanted
Dry					×	×									
Achene				×	×	×									
Dry			×	×	×	×									Wind-carried seeds
do					×	×									Very rare

Orders	Genus	Species
No.70 **Compositae.** (*Contd.*)	*Vernonia*	*anceps*
		setigera
		Hookeriana
		scariosa
		nemoralis
		Wightiana
		zeylanica
	Blumea	*crinita*
		angustifolia
	Anaphalis	*pelliculata*
		fruticosa
		Thwaitesii
		zeylanica
	Gynura	*zeylanica*
		hispida
	Emilia	*zeylanica*
	Senecio	*Gardneri*
71 **Stylidiaceae.** No endemics		
72 **Gordeniaceae.** do		
73 **Campanulaceae.** do		
74 **Vacciniaceae.** do		

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Dry				×	×	×									Rare
do					×	×									
do	×	×	×	×	×	×									Common in patinas
do				×	×	×	×								
do	×	×	×	×											Water-loving
do				×	×	×	×								
do	×	×	×	×				×	×	×	×				
do						×									Seed wind-carried
do	×	×													Water-loving. Very rare
do							×								Very rare
do						×									Very rare
do						×	×								Very rare
do				×	×										In patinas
do										×	×				
do							×								In patinas
do							×								
do			×	×	×	×									Very rare

Orders		Genus	Species
No.75 **Ericaceae.**	No. endemics		
76 **Plumbaginaceae.**	do		
77 **Primulaceae.**	do		
78 **Myrsinaceae.**		*Ardisia*	*Willisii*
			polylipis
			Moonii
79 **Sapotaceae.**		*Bassia*	*Moonii*
			neriifolia
			microphylla
			fulva
		Palaquium	*petiolare*
			grande
			rubiginosum
			caniculatum
			Thwaitesii
			laevifolium
			pauciflorum
80 **Ebenaceae.**		*Maba*	*acuminata*
			ovalifolia
			oblongifolia
		Diospyros	*attenuata*

Fruit	Western							Eastern							Remarks
	1.000 ft.	2.000 ft.	3.000 ft.	4.000 ft.	5.000 ft.	6.000 ft.	7.000 ft.	1.000 ft.	2.000 ft.	3.000 ft.	4.000 ft.	5.000 ft.	6.000 ft.	7.000 ft.	
?	×														
Pulpy															Locality ?
do	×	×													Red fruits
Fleshy	×														Very rare
do	×	×													Water-loving
do	×														
do	×														
do	×	×													Sub-gregarious
do	×	×	×	×	×										Water-loving
do			×	×	×	×				×	×				
do	×														Very rare
do	×														Very rare
do	×	×													
do	×														Rare
do	×														Very rare
do	×														Very rare
do	×														
do	×														Very rare

Orders	Genus	Species
No.80 **Ebenaceae.** (*Contd.*)	*Diospyros*	*acuta*
		Gardneri
		quaesita
		hirsuta
		oppositifolia
		Thwaitesii
		Moonii
81 **Styraceae.**	*Symplocos*	*laeta*
		bractealis
		versicolor
		acuta
		cuneata
		hispidula
		Walkeri
		jucunda
		angustifolia
		latiflora
		elegans
		minor
		hebantha
		cordifolia

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy	×														Very rare
do	×	×													
do	×	×													Becoming very scarce
do	×														Water-loving
do	×														Very rare
do	×														
do	×														In damp swampy lands
Fleshy drupe				×	×	×	×				×	×	×		
do						×	×								
do	×	×													Very rare
do		×													Very rare
do	×	×													
do			×	×	×	×									Rare
? do															Locality wanted
do	×	×	×												
? do					×	×						×			Very rare
do				×	×	×					×	×	×		
do					×	×	×					×	×		
do					×	×	×								
? do				×											Very rare
do						×	×							×	Rare

Orders		Genus	Species
No.81 **Styraceae.** (*Contd*)		*Symplocos*	*apicalis*
			marginalis
			coronata
82 **Oleaceae.**		*Linociera*	*purpurea*
83 **Salvadoraceae.**	No endemics		
84 **Apocynaceae.**		*Willughbeia*	*zeylanica*
		Alyxia	*zeylanica*
		Holarrhena	*mitis*
		Wrightia	*flavido-rosea*
			angustifolia
			zeylanica
		Baissea	*acuminata*
		Anodendron	*rhinosporum*
85 **Asclepiadaceae.**		*Gymnema*	*rotundatum*
		Tylophora	*membranifolia*
			cordifolia
			flava
		Ceropegia	*Gardneri*
			parviflora
		Caralluma	*campanulata*
86 **Loganiaceae.**		*Strychnos*	*micrantha*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy drupe	×														Rare
do		×													Rare
do	×	×	×	×					×						
Hard drupe	×							×							
Fleshy	×	×	×												Monkey-eaten fruits
Pulpy	×														Scarlet fruit
Pod	×							×							Wind-carried seed
do								×							Wind-carried seed
do								×							Wind-carried seed
do	×														Wind-carried seed
do		×	×	×	×	×									Wind-carried seed
do			×							×					Rare
Comose seed								×	×						Rare
do	×							×							
do		×	×	×						×	×				
do	×														
do				×	×										Very rare
do								×							Very rare (?)
Winged and comose		×	×												Doubtfully endemic
Pulpy berry	×	×						×							

Order		Genus	Species
No.86	**Loganiaceae.** (*Contd.*)	*Strychnos*	*Benthami*
			cinnamomifolia
		Gaertnera	*rosea*
			Walkeri
			ternifolia
87	**Gentianaceae.**	*Exacum*	*axillare*
			Walkeri
			zeylanicum
			macranthum
		Swertia	*zeylanica*
88	**Hydrophyllaceae.**	No endemics	
89	**Boraginaceae.**	*Cordia*	*oblongifolia*
		Tournefortia	*Walkerae*
90	**Convolvulaceae.**	*Argyreia*	*populifolia*
		Lettsomia	*hancorniaefolia*
		Ipomaea	*jucunda*
91	**Solanaceae.**	No endemics	
92	**Ssrophulariaceae.**	*Adenosma*	*subrepens*
			camphoratum
93	**Orobanchaceae.**	*Christisonia*	*Thwaitesii*
			tricolor

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Pulpy berry	×	×													
do	×	×	×												
do	×	×													Purple fruit. Rare
do			×	×	×	×	×								Dark blue fruit
do					×	×									Blue fruit
Capsule	×														Rare
do					×	×	×								
do	×	×	×	×											
do					×	×	×								In patinas
do						×	×								In patinas
Drupe	×	×													
do	×	×						×							
Dry	×	×	×	×				×	×	×					
do		×													Very rare
Hairy			×												Very rare
Capsule	×														Wet ground. Very rare
do	×														
do			×	×											Very rare
do			×	×	×										

Orders		Genus	Species
No.93	**Orobanchaceae.** (*Contd.*)	*Christisonia*	*albida*
94	**Lentibulariaceae.**	No endemics	
95	**Gesneraceae.**	*Didymocarpus*	*Humboldtianus*
			floccosus
			zeylanicus
		Chirita	*Moonii*
			Walkeri
			zeylanica
		CHAMPIONIA	*reticulata*
		Klugia	*zeylanica*
96	**Bignoniaceae.**	No endemics	
97	**Pedaliaceae.**	do	
98	**Acanthaceae.**	*Cardanthera*	*Thwaitesii*
		Strobilanthes	*viscosus*
			Nockii
			stenodon
			exareolatus
			rhytispermus
			nigrescens
			rhamnifolius
			deflexus

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,600 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Capsule															Very rare
Dry capsule	×	×	×	×	×			×	×	×	×				
do		×													Very rare
do					×	×									
do		×	×												
do	×	×	×	×	×	×	×								
do	×	×	×	×											
do	×	×	×	×											Rare
do	×	×													Water-loving
Capsule								×							Rare
do				×	×	×	×								Gregarious
do						×									Very rare
do										×	×				Very rare
do										×					Rare
do															Material wanted
do				×											Very rare
do				×											Rare
do	×	×	×												

Orders	Genus	Species
No.96 **Acanthaceae.** (*Contd.*)	*Strobilanthes*	*lanceolatus*
		Walkeri
		Thwaitesii
		punctatus
		Arnottianus
		asperrimus
		trifidus
		exsertus
		Gardnerianus
		vestitus
		Hookeri
		calycinus
		laxus
		zeylanicus
		helicoides
		paniculatus
		pulcherrimus
	Barleria	*vestita*
		nutans
	Gymnostachyum	*zeylanicum*
		Thwaitesii

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Capsule	×	×													
do				×	×	×	×								
do			×												Very rare
do						×									Very rare
do				×	×	×									
do	×	×	×	×	×										Gregarious
do	×														Doubtful sp.
do								×							
do				×											Very rare
do				×	×	×	×				×	×			Gregarious
do					×	×	×								Gregarious
do						×	×								Gregarious
do				×	×	×									
do	×	×													Very rare
do				×	×	×									
do		×	×	×											Rare
do				×	×	×	×								
do	×	×	×	×											Rare
do				×	×										Rare
do										×	×				
do															Very rare

Orders	Genus	Species
No.98 **Acanthaceae.** (*Contd.*)	*Gymnostachyum*	*paniculatum*
		sanguinolentu
		hirsutum
	Lepidagathis	*zeylanica*
		Walkeriana
	Justicia	*zeylanica*
		Hookeriana
		Royeniana
	PTYSSIGLOTTIS	*radicosa*
99 **Verbenaceae.**	*Premna*	*purpurascens*
		Thwaitesii
	Glossocarya	*scandens*
100 **Labiatae.**	*Plectranthus*	*nigrescens*
		Gardneri
		capillipes
	Coleus	*inflatus*
		elongatus
	Anisochilus	*velutinus*
	Pogostemon	*rupestris*
		hirsutus
		reflexus

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Capsule	×	×													
do	×	×	×												
do			×	×											Rare
do	×	×	×												
do	×	×	×												
do	×	×													Rare
do	×	×	×												Water-loving
do			×	×	×	×					×				
do		×													On wet rocks
Drupe	×	×													Very rare, ? endemic
do									×	×	×				Rare
Capsular	×							×							
Achene					×	×	×								
do						×	×						×		
do			×	×	×										
do					×	×									
do										×	×				Very rare
do									×	×	×				
do					×	×	×								
do					×	×	×								
do			×	×	×	×	×								

Orders		Genus	Species
No.100	**Labiatae.** (*Contd.*)	*Scutellaria*	*oblonga*
101	**Plantaginaceae.**	No endemics	
102	**Nyctaginaceae.**	do	
103	**Amarantaceae.**	*Cyathula*	*zeylanica*
		Psilotrichum	*scleranthum*
		Achyranthes	*diandra*
104	**Chenopodiaceae.**	No endemics	
105	**Polygonaceae.**	do	
106	**Podostemaceae.**	*Dicraea*	*elongata*
		Farmeria	*metzgerioides*
107	**Nepenthaceae.**	*Nepenthes*	*distillatoria*
108	**Aristolochiaceae.**	No endemics	
109	**Piperaceae.**	*Piper*	*Thwaitesii*
			zeylanicum
			trineuron
		Peperomia	*pseudo-rhombi*
			confusa
110	**Chloranthaceae.**	No endemics	
111	**Myristicaceae.**	*Myristica*	*zeylanica*
			Horsfieldia
112	**Monimiaceae.**	HORTONIA	*floribunda*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Achene	×	×	×	×	×	×	×				×	×	×		Water-loving
Dry, thin								×							Very rare
Membranous	×							×							
															Locality wanted
Capsule	×	×													In rivers
do		×													Riverine
do	×	×						×							In wet soils
Globose, pulpy					×	×									Red fruit
do					×	×									
do	×	×	×	×											
Dry			×	×	×							×			On moist rocks
do			×	×	×										On trees
Fleshy								×	×	×					Rare. Coloured aril
do	×	×	×												Coloured aril
Pulpy				×	×		×								

Orders	Genus	Species
No.112 **Monimiaceae.** (*Contd.*)	HORTONIA	*angustifolia*
113 **Lauraceae.**	*Cryptocarya*	*membranacea*
	Beilschmiedia	*zeylanica*
	Cinnamomum	*multiflorum*
		ovalifolium
		litseaefolium
		citriodorum
	Actinodaphne	*molochina*
		stenophylla
		elegans
		glauca
		pisifera
		ambigua
		speciosa
	Litsea	*undulata*
		cauliflora
		Hookeriana
		nemoralis
		ovalifolia
		glaberrinia
		iteodaphne

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Pulpy	×	×													By streams
Ovoid	×														Purple fruits
do			×	×											Purple fruits
do					×										
do					×	×	×					×	×		
?					×										Very rare
Ovoid	×														Dark purple fruit. Very rare
Globose						×	×								
do	×	×	×	×					×	×					Purple fruit. In patinas
Fleshy	×	×	×												Red fruits
Minute							×								Rare
?						×	×					×			Rare
Ovoid				×	×	×					×	×			Rare
do					×	×	×					×			
Globose	×	×													Rare
do	×	×	×												
?															Material wanted
Ovoid	×														Very rare
do			×	×	×	×	×				×	×	×		Purple fruits
Globose					×	×	×					×	×		Dark purple fruits
Ovoid				×	×	×									Purplish-red fruits

Orders		Genus	Species
No 113 **Lauraceae.** (*Contd*)		*Litsea*	*Gardneri*
			fuscata
		Lindera	*lancifolia*
114 **Proteaceae.**		*Helicia*	*zeylanica*
115 **Thymelaeaceae.**		*Pimelea*	*cauliflora*
		Gymnops	*Walla*
116 **Elaeagnaceae.**	No endemics		
117 **Loranthaceae.**		*Loranthus*	*nodiflorus*
			mahaeoides
			ensifolius
			sclerophyllus
			ligulatus
			suborbicularis
			lonchiphyllus
			Gardneri
		Notothixos	*floccosus*
		Ginalloa	*spathulifolia*
118 **Santalaceae.**	No endemics		
119 **Balanophoraceae.**		*Balanophora*	*Thwaitesii*
120 **Euphorbiaceae.**		*Bridelia*	*Moonii*
		Cleistanthus	*acuminatus*

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	
Ovoid				×	×	×							
Globose						×	×						
Ovoid											×		Material wanted
do		×	×	×					×				Purplish fruit
Fleshy	×												Crimson fruit. Rare
Capsule	×	×	×	×				×	×				
Berry	×	×											
do								×	×				Very rare
do	×												
do					×	×	×				×		
do	×						×						Rare
do						×	×						Crimson fruit
do			×										Red fruit. Very rare
do	×	×											Red fruit. Very rare
Ovoid do	×												Yellowish fruit
do		×				×							Very rare
?				×	×	×							Rare
Drupe		×					×						
Capsule	×												

Orders	Genus	Speceis
No.120 **Euphorbiaceae.** (*Contd.*)	*Cleistanthus*	*robustus*
		pallidus
		ferrugineus
	Sauropus	*retroversus*
		assimilis
		rigidus
	Phyllanthus	*Thwaitesianus*
		myrtifolius
		Baillonianus
		anabaptizatus
		oreophilus
		hakgalensis
		cinerens
		affinis
		cyanospermum
	Glochidion	*brachylobum*
		pycnocarpum
		rigidum
		coriaceum
		nemorale
		Gardneri

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Capsule	×														Rare
do	×			×				×	×						
do	×	×	×												
Fleshy				×											Very rare
do			×												Very rare
do								×	×						Rare
Dry capsule								×							
Small		×						×	×						Water-side. Rare
Globose	×	×	×							×					
Small					×										Water-loving. Very rare
do								×					×		
do							×								Very rare
do											×				
do							×								Very rare
do	×														Blue arillus
Succulent			×												
?										×					
Small	×	×	×						×						
do				×	×	×									
do	×														Very rare
do	×														Red cocci

Orders	Genus	Species
No.120 **Euphorbiaceae.** (*Contd.*)	*Glochidion*	*monanum*
		Moonii
	Putranjiva	*zeylanica*
	Hemicyclia	*lanceolata*
		Gardneri
	Aporosa	*latifolia*
		lanceolata
		fusiformis
	Antidesma	*pyrifolium*
	Croton	*Moonii*
		nigro-viridis
	Trigonostemon	*diplopetalus*
	Agrostistachys	*Hookeri*
	Adenochlaena	*zeylanica*
	PODADINA	*sapida*
	Claoxylon	*oligrandum*
	Mallotus	*eriocarpus*
		Walkerae
		fuscescens
	Macaranga	*digyna*
	Chaetocarpus	*pubescens*

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Small			×							×	×				Rare
do	×	×	×	×	×	×					×				
Drupe		×													Very rare
do															Very rare
Pulpy, drupe	×							×							
Pulpy	×														
do	×	×													Yellowish fruits
do				×	×	×									
Juicy	×	×	×	×					×	×	×				
Globose	×														Very rare
Woody			×	×	×					×	×				
Fleshy	×														Very rare
Globose	×														Near water
Small			×	×	×						×				
Fleshy	×														Red fruit. Very rare
Small		×	×	×							×				
Globose								×							
Capsule	×	×	×					×	×	×					
do	×	×													
	×														Rare. In wet places
Capsule	×														Very rare

Orders		Genus	Species
No.120	**Euphorbiaceae.** (*Contd.*)	*Chaetocarpus*	*coriaceus*
121	**Urticaceae.**	*Ficus*	*candiculata*
			Mooniana
			Thwaitesii
		Artocarpus	*nobilis*
		Allaeanthus	*zeylanicus*
		Elatostema	*Walkerae*
		Pouzolzia	*Walkeriana*
		Debregeasia	*zeylanica*
122	**Ceratophyllaceae.**	No endemics	
123	**Cycadaceae.**	do	
124	**Hydrocharitaceae.**	*Blyxa*	*zeylanica*
125	**Burmanniaceae.**	*Burmannia*	*Championii*
		Thisma	*Gardneriana*
126	**Orchidaceae.**	*Oberonia*	*truncata*
			Thwaitesii
			longibracteata
			zeylanica
			tenuis
			forcipata

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Capsule	×														
Fleshy	×														Very rare
do	×	×	×												Red fruits
do	×	×	×	×					×	×					
do	×	×							×						
do	×								×						
do				×											Very rare
Small	×														
Fleshy	×	×													
	×							×							Water-carried
	×	×													A saprophyte
		×													Very rare
$\frac{1}{10}$ inch			×	×											
Minute	×														Very rare
$\frac{1}{10}$ inch				×	×	×									
$\frac{1}{8}$ inch						×						×			Rare
$\frac{1}{10}$ inch	×														Very rare
$\frac{1}{10}$ inch		×	×	×											

Orders	Genus	Species
No.126 **Orchidaceae.** (*Contd.*)	*Oberonia*	*scyllae*
	Microstylis	*purpurea*
		discolor
		lancifolia
	Liparis	*Thwaitesii*
		Trimenii
		barbata
		brachyglottis
		obscura
	Dendrobium	*panduratum*
		diodon
		Macarthiiae
	Bulbophyllum	*crassifolium*
		petiolare
		purpureum
		elegans
		sp. nov.
	Cirrhopetalum	*grandiflorum*
		Wightii
		Trimenii
		Macraei

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
?				×	×	×					×				
⅔ inch	×														Near water, very rare
⅓ inch	×	×	×	×	×	×									
do	×	×													Near water
?	×														Very rare
¼ inch				×											Very rare
?															Material wanted
												×			Very rare
		×	×	×							×				
			×	×	×	×									
¼ inch					×	×						×			
Large	×	×													In wet forests
Ovoid		×													Very rare
⅓ inch	×	×													
		×	×							×					
Ellipsoid			×	×	×	×									
?											×				Rare
1½ inches			×	×	×	×									
		×		×	×	×	×								
							×								
			×	×	×										

Orders	Genus	Species
No. 126 **Orchidaceae.** (*Contd.*)	*Cirrhopetalum*	*Thwaitesii*
	Coelogyne	*brevicuspa*
		zeylanica
	ADRORHIZON	*purpurascens*
	Chrsoglossum	*maculatum*
	Acanthophippum	*bicolor*
	Eria	*baccata*
		bicolor
		tricolor
		Lindleyi
		Thwaitesii
	ALVISIA	*tenuis*
	Arundina	*minor*
	Agrostophyllum	*zeylanicum*
	Ipsea	*speciosa*
	Phajus	*Wallichii*
		luridus
	Calanthe	*purpurea*
	Polystachya	*zeylanica*
	Sarcochilus	*viridiflorus*
		pulchellus

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	
⅜ inch				×	×	×	×						
1¼ inches					×	×							
		×											
¾ inch				×	×	×	×						
1¼ inches				×	×								Rare
	×	×											
½ inch				×	×	×	×		×				
					×	×							
				×	×								
				×	×	×	×						
½ inch		×	×	×	×	×							
	×	×											
1 inch	×	×	×	×									
					×	×							
			×	×	×	×							In patinas
2 inches			×	×	×	×	×						In open places
2 inches	×	×											Rare
1½ inches	×	×	×										
½ inch	×	×	×	×					×				
1½ inches						×							Very rare
2-3 inches	×	×											

Orders	Genus	Species
No. 126 **Orchidaceae.** (*Contd.*)	*Sarcochilus*	*pugionifolius*
		complanatus
	Vanda	*Thwaitesii*
	Saccolabium	*niveum*
		gracile
		brevifolium
		roseum
		acaule
	Cleisostoma	*maculosum*
		decipiens
	Mystacidium	*zeylanicum*
	Taeniophyllum	*Alwisii*
	Podochi'us	*falcatus*
		saxatilis
	OCTARRHENA	*parvula*
	Hetaeria	*Gardneri*
	Cheirostylis	*parvifolia*
	Anaectochilus	*regalis*
	Zeuxine	*regia*
	Tropidia	*Thwaitesii*
		bambusifolia

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
?								×							Rare
2-3 inches	×	×	×							×					Rare
										×					
$\frac{1}{8}$ inch			×	×	×	×									
$\frac{1}{6}$ inch				×			×								Very rare
?			×	×	×	×									
$\frac{1}{4}$ inch				×	×	×									
1 inch			×	×	×					×	×				
$1\frac{1}{4}$ inch	×	×	×												
$\frac{3}{4}$ inch	×	×	×												
$\frac{3}{4}$ inch	×							×							
$\frac{1}{2}$ inch				×	×	×					×				
$\frac{1}{4}$ inch			×	×	×	×					×	×			On rocks
$\frac{1}{10}$ inch		×	×	×											
?				×	×	×	×					×	×		
?	×	×	×												Rare
		×	×	×											Rare
$\frac{1}{4}$ inch	×	×	×						×	×					
			×												
$\frac{3}{4}$ inch								×							In high grass
?						×	×								Rare

Orders	Genus	Species
No. 126 **Orchidaceae.** (*Contd*).	*Vanilla*	*Moonii*
	Habenaria	*acuminata*
		dolichostachya
		dichopetala
		pterocarpa
		rhyncocarpa
		breviloba
		Trimeni
		Gardneri
127 **Scitamineae.**	*Curcuma*	*oligantha*
		albiflora
	Alpinia	*rufescens*
	Amomum	*floribundum*
		involucratum
		nemorale
		acuminatum
		fulceps
		masticatorum
		graminifolium
		ciliatum
		pterocarpum

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	
4 inches	×												
Capsular				×	×	×		×					Terrestial
do				×	×	×							Rare
do							×						
		×	×	×									Rare. Near water
1 inch		×	×	×				×	×	×			
?	×	×											Rare
?								×					
?						×	×						
Membranous	×						×						
?		×											Very rare
?				×									Very rare
			×	×									Rare
Ovoid				×	×	×							
do	×												Rare
?	×												Very rare
			×	×									
Globose			×	×									
?	×												
?	×												Very rare
Fleshy		×	×	×									

Orders		Genus	Species
No.127 **Scitamineae.** (*Contd.*)		*Amomum*	*echinatumm*
			Benthamianum
		Zingiber	*cylindricum*
		CYPHOSTIGMA	*pulchellum*
		Phrynium	*zeylanicum*
128 **Haemodoraceae.**	No endemics		
129 **Amaryllidaceae.**	do		
130 **Taccaceae.**	do		
131 **Dioscoreaceae.**		*Dioscorea*	*intermedia*
132 **Roxburghiaceae.**	No endemics		
133 **Liliaceae.**		*Asparagus*	*zeylanicus*
		Urginea	*rupicola*
134 **Pontederiaceae.**	No endemics		
135 **Xyridaceae.**			
136 **Commelinaceae.**		*Commelina*	*Thwaitesii*
		Cyanotis	*obtusa*
			zeylanica
137 **Flagellariaceae.**	No endemics		
138 **Juncaceae.**	do		
139 **Palmaceae.**		*Areca*	*concinna*
		LOXOCOCCUS	*rupicola*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Fleshy	×	×	×	×											Fruits with hooked spines
Ovoid	×														Spined fruit. Very rare
Spongy, fleshy	×	×	×	×					×	×					
Fleshy	×	×	×	×	×										
Oblong	×								×						Fleshy aril. Rare
Capsule	×	×	×						×	×					
Berry		×	×	×	×	×	×			×	×	×			
Capsule	×							×							Very rare
do											×				Rare
$\frac{1}{10}$ in. do									×						Very rare
1/6 in. do					×					×	×				
Ovoid	¼														In flooded areas
¾ in. do			×	×	×						×	×			In rocky places

Orders		Genus	Species
No.139 **Palmaceae.** (*Contd.*)		*Oncosperma*	*fasciculatum*
		Phoenix	*zeylanica*
		Calamus	*rivalis*
			delicatulus
			radiatus
			pachystemonus
			digitatus
			zeylanicus
			ovoideus
140 **Pandanaceae.**		*Pandanus*	*zeylanicus*
		Freycinetia	*pycnophylla*
			Walkeri
141 **Typhaceae.**	No endemics		
142 **Araceae.**		*Cryptocoryne*	*Thwaitesii*
			Nevillii
			Walkeri
			Beckettii
		Lagenandra	*Thwaitesii*
			lancifolia
			Koenigii
			insignis

Fruit	Western						Eastern						Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	
Globose	×	×	×	×	×			×	×	×			On shallow soil, on rocks
Ovate	×						×						
Ellipsoid	×												Rare. Coloured fruits
½ in., globose	×												
⅓ in. do	×												Yellow fruit
?	×												Rare
⅓ in. globose	×												Pale yellow fruits
¾ in. ,,	×	×											Yellowish brown fruit
Ovoid	×	×											Yellowish grey fruit
Globose	×												Water-loving
	×	×						×					Brilliant red fruit
	×	×	×	×	×								
Syncarp	×												Very rare
							×						Very rare. In marshes
?													Material wanted
?								×	×				Rare
Syncarp	×												Rare
	×												Water-loving
	×												Wet soil
	×												Very rare

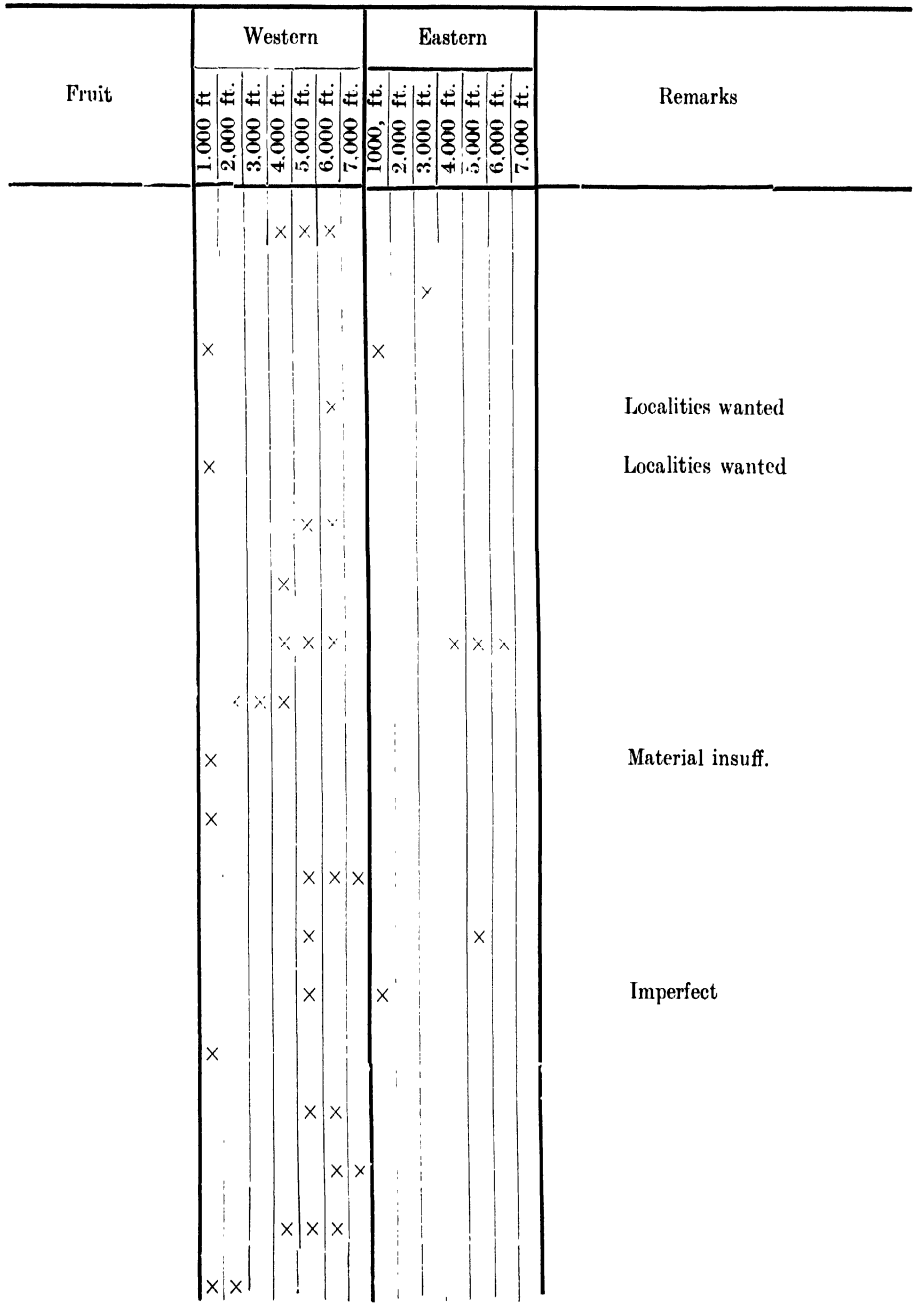
Orders		Genus	Species
No.142 **Araceae.** (*Contd.*)		*Arisaema*	*filicaudatum*
		Theriophorum	*crenatum*
		Amorphophallus	*dubius*
		Pothos	*zeylanicus*
			Hookeri
			remotiflorus
143 **Lemnaceae.**	No endemics		
144 **Triuridaceae.**		*Sciaphila*	*erubescens*
			secundiflora
145 **Alismaceae.**	No endemics		
146 **Naiadaceae.**		*Aponogeton*	*crispum*
147 **Eriocaulonaceae.**		*Eriocaulon*	*caulescens*
			zeylanicum
			longicuspis
			atratum
			Trimeni
			Walkeri
			fluviatile
148 **Cyperaceae.**		*Cyperus*	*Nov. sp.* (*from Ritigala*)
		Fimbristylis	*aestivalis*
			Trimeni

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
Berry		×													Very rare
do	×							×							In grassy places
do	×	×													
do															Material wanted
do	×	×							×						
(?) do	×	×	×	×					×	×					
11/60in. soft	×														Very rare
Soft	×														Very rare
	×	×	×	×	×	×	×	×	×	×	×	×	×		Water plant. Doubtfully endemic
Capsule					×	×	×								Very rare
						×	×								
				×											Very rare
					×	×	×								
								×							
	×							×							Very rare
	×														In running water
										×					
	×														
	×														

Orders	Genus	Species
No.148 **Cyperaceae.** (*Contd.*)	*Fimbristylis*	*fulvescens*
	Hypolytrum	*longirostre*
	Mapania	*immersa*
	Scleria	*junciformis*
	Carex	*Arnottiana*
		spicigera
		zeylanica
		brevicuspa
		lobulirostris
149 **Gramineae.**	*Isachne*	*elatior*
		multiflora
	Panicum	*sparsicomum*
	Oplismenus	*Thwaitesii*
	Arundinella	*laxiflora*
		blephariphylla
		Thwaitesii
	Leptaspis	*cochleata*
	Dimeria	*pubescens*
		Thwaitesii
		Trimeni
	Pollinia	*Thwaitesii*

Fruit	Western							Eastern							Remarks
	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	1,000 ft.	2,000 ft.	3,000 ft.	4,000 ft.	5,000 ft.	6,000 ft.	7,000 ft.	
	×		×					×							
	×														Very rare
	×														Very rare
	×														Very rare
				×	×	×									
			×	×	×					×	×				
						×									
			×												
					×	×	×								
Grain						×									
					×										
								×							Doubtful
								×							
			×	×	×										
	×														
		×													
			×	×											
		×	×	×											
								×							
							×								
						×	×								

Orders	Genus	Species
No.149 **Gramineae.** (*Contd.*)	*Rottboellia*	*nigrescens*
	Ischaemum	*rivale*
	Eremochloa	*zeylanica*
	Cymbopogon	*Thwaitesii*
	Garnotia	*Thwaitesii*
		tectorum
		fuscata
		Fergusonii
		micrantha
		panicoides
	Zenkeria	*obtusiflora*
	Coela hne	*perpusilla*
	Eragrostis	*secunda*
		Walkeri
	Lophatherum	*zeylanicum*
	Arundinaria	*floribunda*
		debilis
	Teinostachyum	*attenuatum*
	Ochlandra	*stridula*


Fruit
Western
Eastern
1,000 ft
2,000 ft.
3,000 ft.
4,000 ft.
5,000 ft.
6,000 ft.
7,000 ft.
1000, ft.
2,000 ft.
3,000 ft.
4,000 ft.
5,000 ft.
6,000 ft.
7,000 ft.
Remarks
Localities wanted
Localities wanted
Material insuff.
Imperfect

It is hoped that further verification both of species and distribution will in time be available in order to secure more complete data as to the exact distribution of Ceylon's endemic flora, but for the present it is hoped that even these imperfect details may be of some service to ecology.

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Additions to Ceylon Fungi

IV. Basidiomycetae

BY

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Clitocybe corrugata Petch, n. sp. Pileus up to 6.5 cm. diameter; broadly convex, then plane, depressed in the centre, blackish brown or greyish brown, paler towards the margin, hygrophanous, with a cartilaginous cuticle which is puckered into radial and transverse ridges, strongly radially striate with dark lines over the gills when moist ; stalk up to 4 cm. high, 1 cm. diameter, equal, pallid, becoming grey when handled, longitudinally fibrillose, mealy at the apex, solid, internally greyish white, expanding into the pileus ; gills very distant, broad (11 mm.), ventricose, sinuate behind, adnato-decurrent, pallid, becoming fuscous when old, interstices strongly veined ; spores white, oval, 6-9 × 4 μ ; strong smell of meal. On the ground among grass, Peradeniya, July 29, 1909 ; October, 1914. Specimens and painting, No. 4202.

There is apparently a figure of this species included among the paintings assigned by Berkeley and Broome to *Collybia multijuga*. The figure shows a similar pileus, but a hollow stem. It is possible that the stem may have been hollowed out by insects.

Clitocybe flavescens Petch, n. sp. Yellowish or ochraceous in the centre, paler towards the margin, broadly convex, then almost plane, slightly depressed in the centre, smooth, up to 3 cm. diameter ; stalk white, faintly longitudinally fibrillose, flexuose, solid, expanding into the pileus, up to 2.5 cm. high, 3.5 mm. diameter ; gills pale yellow, distant, narrow, of three lengths, the longer arcuate, strongly decurrent, interstices veined ; spores globose, 4 μ diameter, with a few oval, 6-8 × 4 μ, white in mass. On the ground among grass, Peradeniya, October 16, 1914 ; specimen and painting, No. 4178.

Mycena farinosa Petch, n. sp. Pileus campanulate, up to 3.5.mm. diameter, white, feebly sulcate, strongly pruinose; stalk whitish, translucent, curved, attenuated upwards, tomentoso-pruinose, up to 5 mm. high, 0.4 mm. diameter, base slightly inflated, no disc ; gills ascending, narrow, distant, white ; spores white, ovoid, 7 × 5 μ, or globose 5 μ.

Pruina on the pileus consists of spherical or ovoid cells, 16-24 μ diameter, echinulate with close-set, short, acute spines, or verrucose, attached to the pileus by a short stalk. Similar cells occur on the stipe, together with others which are larger, ovoid, or sometimes lobed, up to 90 × 20 μ, with a stalk 10 μ long, 6 μ diameter. On the bark of a living jak tree, Peradeniya, November, 1919 ; No. 6145.

Mycena aculeifera Petch, n. sp. Pileus up to 4 mm. diameter, broadly convex, centre ultimately depressed, white, membranous, sparsely covered with conical processes, margin striate ; stalk up to 12 mm. high, 0.5 mm. diameter, attenuated upwards, white, subtranslucent, minutely pruinose, becoming glabrous, arising from a circular fimbriate basal disc ; gills white, distant, narrow, lower edge straight, adnate, united behind over the stalk ; spores white, narrow-oval, 8 × 4 μ ; conical processes solid, up to 80 μ high, 50 μ diameter at the base, apex obtuse. On dead roots and rhizomes of Amomum, Peradeniya, December 17, 1914 ; specimen and painting, No. 4379.

When the fungus first begins to expand, the fimbriate edges of the basal disc form a cup ; the disc partly covers the pileus at first, *i.e.*, it represents a universal veil. This species is apparently included in the specimens assigned by Berkeley and Broome to *Mycena tenerrima*.

Mycena grisea Petch, n. sp. Pileus hemispherical, or broadly convex, or conico-campanulate, apex rounded, or in the larger specimens slightly obtusely umbonate, up to 2 cm. diameter, 1 cm. high, membranous, brownish grey or livid grey, with a central darker spot, glabrous, minutely hoary when dry, sulcate nearly to the centre, margin pale, recurved when old ; stalk up to 3.5 cm. high, 1.5 mm. diameter, equal, subtranslucent, blackish brown below, pallid above, with a few radiating fascicles of hairs at the base, hollow, sometimes exuding a clear liquid when broken ; gills white, then pallid, narrow, distant, attenuated outwards, edge straight, adnate with a decurrent tooth or line, interstices sometimes veined ; cystidia not found ; spores white, narrow-oval or culvate, 6-11 × 3-4 μ. On dead wood, decaying stumps, decaying fruits, Peradeniya ; type specimen and painting, No. 2885, July 16, 1909. Smell alkaline.

Mycena rorida Fr. Pileus up to 7 mm. diameter, hemispherical, or broadly convex, sometimes becoming plane, slightly depressed in the centre, white, pellucid, sprinkled with minute grey points, feebly radially striate ; stalk up to 2.8 cm. long, 0.75 mm. diameter, slightly attenuated upwards, white, subtranslucent, clothed with a thick layer of transparent gluten which tends to acumulate in the lower half, sometimes fuscous at the base, sometimes bulbous, sometimes with a narrow tuft of white fibrils ; gills white, of three lengths, distant, the longer

broad, arched, decurrent, edge toothed ; cystidia in groups, cylindric, 20 × 8 μ, or clavate, 16-24 μ high, 4 μ diameter below, expanding to 8-10 μ diameter above ; spores white, or faintly yellow, narrow-oval or clavate, 7-10 × 3-4 μ. On dead leaves and twigs, Peradeniya, October 19, 1914, etc., specimens and painting, No. 4188.

Coprinus macrorhizus (Pers.) Rea. On the ground, and on decaying palm nuts, Peradeniya, June 7, 1923 ; No. 6623.

Pileus at first conico-campanulate, obtuse, unexpanded pileus up to 1.3 cm. high, 1.5 cm. diameter, densely covered with fibrillose overlapping scales, dark grey, livid brown when the scales are removed ; becoming plane, 3 cm. diameter, bay brown in the centre, elsewhere sodden and blackish, very minutely pruinose, plicato-sulcate up to the bay brown centre. When expanded under a bell glass, the scales persist as floccose patches, and the margin may be recurved. Gills crowded, at first adnexed, becoming free, edge straight, outer end broadly rounded.

Stalk up to 12 cm. high, with a long rooting base, hollow, attenuated upwards, up to 5 mm. diameter below, 2 mm. diameter above, at first densely clothed with floccose, upwardly directed scales, becoming slightly floccose, or almost smooth, white. Spores dark brown by transmitted light, broadly oval or subglobose, sometimes slightly apiculate, 5-10 × 4-6 μ. Cystidia broadly pyriform, 50 × 30 μ.

This is *Coprinus macrorhizus* (Pers.) Rea, as figured by van Overeem, Icones Fungorum Malayensium, plate VI. Its spores are smaller than given by Rea for the European species.

Campanella purpureobrunnea Petch, n. sp. Orbicular, about 1 cm. diameter, sessile, convex, radially sulcate, sometimes reticulated, glabrous, subgelatinous, margin thin, blackish brown to purple brown, with the margin tending to lavender ; hymenium dark purple ; gills broad, distant, forked, radiating from beneath the point of attachment of the pileus, united by numerous cross septa ; basidia clavate, up to 18 μ long, 5 μ diameter, four-spored ; sterigmata slender, up to 4 μ long ; spores white in mass, globose, 3-4 μ diameter. On bark, Hakgala, April 20, 1919 ; No. 5988. Turns black when dry.

Laschia ? pezizaeformis B. & C. Sessile, circular, attached by a broad base, or orbicular with one-half reflexed, up to 3 mm. diameter, 1-1.5 mm. thick, subgelatinous, dorsal surface subreticulated, glabrous, greyish or brownish white, convex ; pores few, irregularly hexagonal or pentagonal, about 0.25 mm. diameter, pallid, pore surface plane ; spores white, broadly oval, 8 × 6 μ ; basidia broadly clavate, 15 × 6 μ, four-spored, sterigmata stout, cylindric, about 6 μ long ; cells of pileus

and on gills ovate, not crested. On dead wood, **Hakgala**, September, 1908 ; No. 2995.

Hydnum fragile Petch, Ann. Perad., VII, p. 287 (1922).

This name is antedated by the well-known *Hydnum fragile* Fr. The species may be known as *Hydnum scabrum*.

PHYCOMYCETAE

Synchytrium fuscum Petch, n. sp. Galls minute, black, gregarious on the leaf, or clustered on swollen purple areas on the stem. Resting spores about three in each gall, solitary in the host tissue, dark brown, almost black, when fresh, yellow-brown in herbarium specimens, 85-100μ diameter, wall 8-12 μ thick, the inner wall 2-3 μ thick, contents at first yellow, dividing into hyaline, subglobose swarm spores, 3-4 μ diameter. On *Emilia sonchifolia*, Galboda, December, 1911; No. 3367.

PYRENOMYCETAE

Hyponectria Eugeniae Petch, n. sp. Hypophyllous, without evident spots ; perithecia gregarious, immersed subprominent, subconoid, up to 0.5 mm. diameter, 0.4 mm. high, orange red ; wall yellow ; asci cylindric, apex truncate and thickened, shortly pedicellate, 140-160 × 6 μ, spores uniseriate ; paraphyses numerous, linear, as long as the asci ; spores cymbiform, hyaline, continuous, ends rounded, 12-16 × 5 μ. On leaves of *Eugenia mabaeoides*, Hakgala, April, 1917 ;No. 5234.

Sphaerella rosigena Ell. and Ev. On Rosa cult., Peradeniya, October, 1919 ; No. 6127.

Trichosphaeria dactylosporifera Petch, n. sp. Perithecia scattered, superficial, globose, about 0.25 mm. diameter, black, not carbonaceous, sparsely clothed with spreading rigid conidiophores ; conidiophores up to 150 μ long, 6 μ diameter, septate, equal, sometimes geniculate above, brown, hyaline at the apex, bearing solitary, oval or broadly cymbiform, thick-walled conidia, muriform, not constricted, greenish olivaceous, then opaque, 18-20 × 12-15 μ ; asci broadly clavate or oval, sporse irregularly biseriate, 100 × 24-32 μ ; ascospores hyaline, oval inequilateral, or subcymbiform, ends obtuse, 22-32 × 12-14 μ. On a dead branch, Gangaruwa, December, 1913 ; No. 4108.

Trichosphaeria fasciculifera Petch, n. sp. Perithecia scattered, superficial, globose, 0.2-0.3 mm. diameter, black, not carbonaceous, with repent dark-brown hyphae spreading radially from the base over the substratum, clothed elsewhere with flexuose, dark-brown hyphae, 4 μ diameter, loosely united into erect, rigid, pointed fascicles, up to 0.4 mm.

long; ostiolum not elevated; asci about 90 × 12 μ, clavate, eight-spored, spores obliquely uniseriate; spores hyaline, ellipsoidal, 12-16 × 6 μ, On dead stems of Lantana, Peradeniya, January 11, 1914; No. 3876.

Zignoella tuberculata Petch, n. sp. Perithecia superficial, clustered-ovoid, 0.2 mm. diameter, black, rugose with minute protuberances; ostiolum minute, conical, scarcely evident; wall leathery, not carbonaceous, parenchymatous, of rather large polygonal cells, 10-16 μ diameter; asci broadly clavate, apex rounded, thick-walled, shortly pedicellate, eight-spored, spores biseriate, 136 × 24 μ; paraphyses numerous, linear, as long as the ascus; spores hyaline, fusoid, multiseptate, with up to eleven septa and containing numerous globules, 48-60 × 8-10 μ. On dead branches of *Mangifera indica*, Peradeniya, July 6, 1919; No. 6033.

Leptosphaeria depressa Petch, n. sp. Perithecia scattered, semi-immersed, depresso-globose, about 0.2 mm. diameter, black, not carbonaceous, ostiolum conical; asci thick-walled, broadly clavate or ovoid, scarcely pedicellate, four or eight-spored, spores obliquely uniseriate or biseriate, 64-100 × 16-20 μ; paraphyses stout; spores narrow oval or cymbiform, rather thick-walled at first, three-septate, slightly constricted the septa, pale-brown, ends obtuse, 20-24 × 8 10 μ. On stems of *Camellia theifera*, Spring Valley, November, 1914; No. 4347.

Rhynchosphaeria sepulta Petch, n. sp. Perithecia immersed in the wood, black, globose, 0.25-0.3 mm. diameter, scattered, wall membranous, readily separating from the matrix, with a projecting, cylindrical ostiolum, up to 0.6 mm. long, 0.1 mm. diameter; asci 54-60 × 8 μ, narrow clavate, with a short pedicel expanded at the base, eight-spored, spores biseriate above, uniseriate below; paraphyses filiform, longer than the asci; spores cylindric or subfusoid, ends obtuse, straight or slightly curved, three-septate, not or slightly constricted at the septa, brown, 10-13 × 4-5 μ. On dead stems of *Panax fruticosus*, Peradeniya, January, 1907; No. 2171.

Rosellinia caudata Petch, n. sp. Perithecia superficial, embedded at first in a dense purple-black subiculum which disappears with age, carbonaceous, black, becoming brown with a black apical area, glabrous, globose to subcylindric, rounded above, up to 1 mm. diameter, 1.25 mm. high, ostiolum conical, acute; asci cylindric, shortly pedicellate, apex rounded and thickened, 200-220 × 12 μ, spores obliquely uniseriate; spores dark brown, narrow oval, slightly inequilateral, ends obtuse, 24-30 × 8-9 μ, with a hyaline coat which is sometimes prolonged at one end into an appendage, 2 μ diameter, as long as the spore. On dead twigs of *Cinnamomum Camphora*, Hakgala, September, 1908; No. 2819.

Rosellinia tenuistromicola Petch, n. sp. Perithecia superficial, scattered, on a thin purple subiculum, carbonaceous, globose, black, minutely adpressed tomentose, 0.7-0.8 mm. diameter, ostiolum papillaeform, 0.05 mm. high ; asci, sporiferous part, 120 × 7 μ, spores uniseriate : spores cymbiform, blackish brown, ends acute or obtuse, 12-18 × 5-7 μ. On dead stems, Peradeniya, January, 1912 ; No. 3399.

Rosellinia obtusa Petch, n. sp. Perithecia erumpent, becoming superficial, scattered, carbonaceous, globose, 0.4 mm. diameter, black, smooth, ostiolum not elevated ; asci clavate, 100-110 × 8 μ, spores obliquely uniseriate above, uniseriate below ; spores oval or subcymbiform, ends obtuse, black-brown, 12-14 × 5 μ. On dead twigs of *Cinnamomum Camphora*, Hakgala, January, 1, 1914 ; No. 3878.

Rosellinia decidua Petch, n. sp. Perithecia erumpent, then almost superficial, gregarious, sometimes confluent, black, globose, minutely rough, up to 1.2 mm. diameter ; ostiolum minute, scarcely elevated, surrounded by a smooth, sometimes depressed ring ; wall up to 0.4 mm. thick, the outer layer scaling off when old and leaving a somewhat fleshy reddish wall ; asci cylindric, 100-120 × 5 μ, with a long tapering pedicel, spores uniseriate or slightly obliquely uniseriate ; spores dark brown, narrow oval, ends obtuse, with a large central gutta, 9-12 × 3-4 μ. On dead branches of *Cinnamomum Camphora*, Hakgala, September, 1908; No. 2818.

Rosellinia immersa Petch, n. sp. Perithecia superficial, embedded in a dense purple black subiculum, carbonaceous, black, broadly globose, about 1 mm. diameter, minutely rugose or almost smooth, sometimes with a slightly depressed area, 0.2 mm. diameter round the ostiolum ; ostiolum short, conical ; asci cylindric, sporiferous part 180-200 × 12-14 μ, spores uniseriate ; paraphyses linear ; spores cymbiform, slightly curved, ends obtuse, black-brown, with a hyaline coat up to 2 μ thick, 20-36 × 7-10 μ. On dead branches, Peradeniya, January, 1912; No 3344.

Diatrype conferta Petch, n. sp. Stromata small, up to 1.25 mm. diameter, 0.8 mm. high, erumpent, gregarious, circular or oval, pulvinate, black, rugose, not carbonaceous, ostiola not projecting ; internally white, then purple brown ; perithecia few in each stroma and occupying nearly the whole, irregularly globose, up to 0.5 mm. diameter, with a cylindrical, totally immersed neck, up to 0.25 mm. high, 0.12 mm. diameter ; asci, total length 70-80 μ, broadly clavate above, 12 μ diameter, with a long thin pedicel up to 35 μ long, eight-spored ; paraphyses numerous, filiform, longer than the asci, spores cylindric, curved, ends obtuse, olivaceous, bi-guttulate, 8-13 × 1.5-2.5 μ. On branches of *Camellia theifera*, Kandapola, September, 1909 ; No. 2987.

Penzigia microspora Petch, n. sp. Stromata superficial, 1-3 mm. diameter, flattened turbinate, centrally attached, up to 1 mm. thick in the centre, oval or subcircular, usually gregarious and angled by mutual interference forming tesselated sheets, sometimes confluent, purple grey with black projecting ostiola, perithecial elevations not evident, margin rounded, not brittle, internally white, fleshy, with a thin black cortex ; perithecia usually in a single layer, crowded, black, ovoid or subglobose, 0.22-0.28 × 0.18-0.2 mm. ; wall of perithecium dark reddish brown by transmitted light ; asci narrow clavate, eight-spored, spores obliquely uniseriate, sporiferous part 30-36 × 5-6 μ, with a tapering pedicel up to 30 μ long ; paraphyses linear ; spores oblong or oblong-oval, ends rounded, pale fuscous with a thick hyaline coat and a central pale band, 4-6 × 2.5-3 μ. On dead wood, Anuradhapura, December, 1919 ; No. 6213.

DISCOMYCETAE

Dothiora Symploci Petch, n. sp. Spots red-brown with a blackish margin ; apothecia amphigenous, up to 1 mm. diameter, at first black, rugose, surrounded by the upturned epidermis, the black cover splitting off, leaving the apothecium white and subgelatinous : no black stroma beneath or round the fructification ; asci broadly oval, very shortly pedicellate, thick-walled, 90-100 × 40 μ, eight-spored, spores irregularly arranegd : paraphyses stout, about 2.5 μ diameter, branched, longer than the asci : ascospores fusoid, muriform, transverse septa about 4 μ apart, not constricted at the septa, 32-36 × 12-13 μ. On leaves of *Symplocos spicata*, Hakgala, May, 1910 ; No. 3142.

Haematomyces carneus Petch, Ann. Bot., XXXIII (1919), p. 418

This name is antedated by *Haematomyces carneus* Rehm. The species may be known as *Haematomyces cerebriformis*.

Henriquesia Ochlandrae Petch, n. sp. Perithecia erumpent, scattered, circular or elongated, up to 0.6 mm. long, 0.3 mm. broad, 0.2 mm. high, black, rough, thick-walled, opening by a longitudinal slit : asci cylindrico-clavate, 130 × 10 μ, spores uniseriate ; paraphyses numerous, linear, not forming an epithecium ; spores oval, hyaline, 16-20 × 7-10 μ. On living leaves of *Ochlandra stridula*, Gikiyanakande, June 7, 1916 ; No. 4802.

HYPHOMYCETAE

Gliocladium microsporum Petch, n. sp. White, forming sub-cylindric or spreading lax fascicles, up to 0.6 mm. high, 0.1 mm. diameter at

the base ; conidiophores branched near the base, simple above, 4 μ diameter below, slightly attenuated upwards, 3 μ diameter above, hyaline, septate, straight, somewhat rigid, closely and minutely verrucose, bearing at the apex a few, usually four, cylindric prophialides, curved below, 8 μ long, 2 μ diameter, each bearing two to four elongated flask-shaped phialides, 8-16 μ long, 1.5 μ diameter below, the prophialides and phialides forming a lanceolate head, 16-24 × 8-10 μ ; conidia adhering in a globose mass up to 30 μ diameter ; conidia hyaline, oblong-oval, 1.5-3 × 0.75-1 μ, or subglobose, 1 μ diameter. On *Polystictus flabelliformis*, Hakgala, January, 1914 ; No. 6820.

Apparently differs from *Gliocladium penicillioides* Corda in its smaller spores, and conidiophores not thickened above.

Hormiscium pulvinatum Petch, n. sp. Tufts superficial, pulvinate or subglobose, up to 0.6 mm. diameter, 0.5 mm. high, black, pulverulent, composed of loose branching chains of conidia ; conidia not separating, blackish brown, thick-walled, smooth, broadly oval, 5-6 × 3.5-4 μ, or cuboid or subglobose, 3.5-4 μ diameter. On wood, Hakgala, September, 1914 ; No. 4240.

Helminthosporium Oryzae B. de H. On glumes of rice, Anuradhapura, February, 1920 ; No. 6173.

Helicosporium recurvum Petch, n. sp. Tufts black, effused, more or less circular : conidiophores clustered, up to 180 μ high, 6 μ diameter, brown, septate, equal ; conidia 7-8 septate, not constricted at the septa, once coiled, coil 15-19 μ diameter, with a recurved conical basal part, 6-8 μ long, 4 μ diameter. On dead mango branches, Peradeniya, November, 1914 ; No. 4334.

Some New Ceylon Plants

BY

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WITH TWO PLATES

Among the generic characters of *Alyxia* Banks, Brown (4) gave. "I. corolla fauce nuda ; II. semen semi-bipartitum ; III. albumen ruminatum corneum ; IV. embryo erectus," and added "Obs. II. Habitu et floris fructura Apocinis et veris similis, diversa albumine ruminato facillimeque in lobis separando centro tantummodo solido embryonifero, embryo rectus v. curvatus," and further "An cum *Rauvolfia* et *Ophioxylo* in propria sectione jungenda ? licet in his ovarium semi-bilobum, loculis monospermis, albumen tenue carnosum non ruminatum et embryo major foliaceus." These comments go to shew the importance of the ruminate endosperm and the two-lobed embryo as generic characters of *Alyxia* Banks.

Wight (7) described and figured a plant, *Alyxia ceylanica*, which Schumann (11), p. 151, who restored the genus *Gynopogon* Forst., making *Alyxia* Banks a synonym, renamed *Gynopogon zeylanicus*. Hooker (10) referred to the plant as *Alyxia ceylanica* Wight and noted "Very dissimilar from the other species, if indeed congeneric." Trimen (12), p. 127, called it *Alyxia zeylanica* Wight and said in a footnote "This must be referred to *Alyxia* with some doubt ; the endosperm is not ruminate."

An examination of fresh specimens of the plant shewed I. the throat of the corolla tube hairy ; II. the seeds not bipartite in the least ; III. the embryo not ruminate and not horny, but fleshy; IV. the embryo inverted. This plant, which has I. stamens free from the stylar head ; II. thecae full of pollen and without spines; III. seeds without hairs, belongs to the Plumieroideae. As its two carpels are free it comes under the section Plumiereae. Characterised by the small number of ovules in each loculus and the thin seed coat it comes under subsection Rauwolfiinae.

According to Schumann's key (11), p. 150, to the "Plumieroideae-Plumiereae-Rauwolfiinae," this plant works down to :—

A. Blumenkronenzipfel links deckend.
a. Discus O.
Sa. hangend.
I. Nahrgewebe gleichformig.....*Hunteria.*

On the other hand, Roxburgh (6) gave among the generic characters of *Hunteria* I. germ lobes *two*-seeded; II. *berries two, one or two-seeded.* Also Bentham and Hooker (9) enumerated among the generic characters of *Hunteria* Roxb.; III. antherae oblongo-lanceolatae; IV. semina ovata v. oblonga; V. folia coriacea tenuissime pennivenia; VI. cymae densae v. subpaniculatae. *Alyxia ceylanica* Wight has I. germ lobes 4-6-seeded; II. fruit a string of drupes; III. anthers obcordate; IV. seeds falcate; V. leaves thin; VI. cymes 1-3 flowered. In view of these points of difference, I consider this plant to belong to a perfectly distinct genus, which I propose to call *Petchia* after Mr. T. Petch, late of the Ceylon Department of Agriculture.

Petchia Livera gen. nov. (Apocynaceae-Plumerieae) affinis *Alyxiae* Banks, sed albumino non ruminato differt.

Frutices glabri. Folia 3-natim v. opposita, tenuis venis parum prominulis. Flores parvuli, 3-4-natim in axillis foliorum terminalium pseudo-terminales. Calyx 5-partitus, eglandulosus, segmentis brevibus. Corolla hypocrateriformis, tubo cylindraceo ad stamina dilatato, fauce esquamata; lobi 5 contorti, sinistrorsum obtegentes. Stamina prope faucem inclusa; antherae obcordatae, loculis basi inappendiculatis. Discus O. Ovarii carpella 2, distincta. Stylus filiformis; stigma capitatum, apiculo breviter 2-fido; ovula in quoque carpello 4-6, 2-seriata. Drupae 2 moniliformae, articulis falcatis 1-spermis. Semina falcata, placentam intrusam amplectentia; albumen carnosum.

Species unica, Zeylaniae.

Petchia ceylanica Livera, comb. nov., *Alyxia ceylanica* Wight, Ic. IV. pt. 2. 2 (1850) t. 1293.; Thw., Enum. Pl. Zeyl. 191 (1864); C. P. 1835; Fl. B. Ind., III. 636. (1882); Bedd., Fl. Sylv. Anal. t. 20, f. 5; Trimen F. Ceyl. III. (1895), p. 127. Wal-kaduru, S.

Hunteria Legocii Livera sp. nov. *H. Roxburghiana* Thw., Enum. Pl. Zeyl., 192 (1864) (non Wight Ic.); *H. corymbosa* Trimen, Fl. Ceyl. III. (1895) 128 ex parte; C. P. 2518. Mediya, S.

Frutex erectus, ramis teretibus, glabris, foliis breviter petiolatis lineari-lanceolatis supra nitidis utrinque glabris subcoriaceis, floribus umbellam terminalem referentibus, breviter pedicellatis, pedicellis bracteisque laccatis ; sepalis brevibus triangularibus acutis, glabris ; corolla hypocraterimorpha, tubo duplo lobos superante, staminibus infra faucem insertis, ovario glabro, carpidiis biovulatiis, stilo apice clavato.

Trimen (12), p. 128, noted under *Hunteria corymbosa* Roxb. "The shape of the leaves varies. C. P. 2518 (*H. Roxburghiana*) is a narrow-leaved form, and C. P. 1827 (*H. zeylanica*) a very broad-leaved variety." A re-examination of the two forms shewed that there were in reality two distinct species. C. P. 1827 is the true *H. corymbosa* Roxb. and differs from C. P. 2518 in the characters tabulated below :—

C. P. 1827—*H. corymbosa* Roxb.	C. P. 2518.
1. Leaves oblong-oval or lanceolate, distinctly acuminate, obtuse at the apex.	Leaves linear-lanceolate, acute, but not acuminate at the apex.
2. Calyx lobes ovate.	Calyx lobes triangular.
3. Corolla lobes falcate.	Corolla lobes circular.
4. Anthers dorsifixed, ovate with the lobes rounded at the base.	Anthers versatile, linear-lanceolate, with lobes acute at the base.

C. P. 2518 is, therefore, distinct from *Hunteria corymbosa* Roxb.

Thwaites (8), p. 192, enumerated C. P. 2518 under "? *H. Roxburghiana* Wt. Ic. t. 1294 " and remarked " This would seem to have the leaves narrower and less numerously and strongly veined than Dr. Wight's plant, as represented in his figure, but in other respects there appear, to be great similarity." Wight (7), Vol. IV., pt. 11, p. 2, in his "Explas nation of plates " noted under " t 1294 " " The venation in the figures though correct as to outline, is too conspicuous ; in the specimen it is much less distinctly seen." When we discount this excessive venation, Wight's figure t 1294 and description answer in other respects to Roxburgh's definition (6) of *Hunteria corymbosa*. It is, in fact, admitted by all that *H. Roxburghiana* Wight Ic. t. 1294 is the same as *H. corymbosa* Roxb. The other points of difference between *H. Roxburghiana* Wight and C. P. 2518 are the same as those tabulated above, and Thwaites had overlooked these differences, although he had himself drawn the floral parts in the painting of the plant C. P. 2518, preserved in the Peradeniya herbarium, and from which Plate II. is made. The re-examination of the flowers shewed that the dissections done by Thwaites, were perfectly correct.

The plant C. P. 2518 is, therefore, distinct from *Hunteria corymbosa* Roxb., and I have named it after the Rev. M. J. LeGoc, the first lecturer

in Botany at the Ceylon University College, whose teaching has done so much to stimulate the study of Botany in Ceylon.

Hunteria Legocii Liv. is a glabrous shrub with linear-lanceolate leaves 6.5-8.5 cm. long, and 1.3-2 cm. broad, acute at the apex, veins rather distant. Inflorescence a terminal umbel. Bracts ovate, minute. Calyx 0.1 cm. long. Corolla tube 0.4 cm. long, dilated at the base and towards the mouth ; lobes 0.2 cm. long, rounded. Anthers 0.1 cm. long, linear-lanceolate. Fruit with an obtuse beak.

Badulla and Rikiligasgoda. Fl. July.

Hunteria Zeylanica Gardn. ex Thw., Enum. Pl. Zeyl., p. 191 (1864).

Roxburgh (6) named a plant *Hunteria corymbosa*, " a native of Prince of Wales's Island, where it blossoms in July; in Bengal, in May." He made no mention of it in his earlier work (5). Hermann (1) mentioned a plant " Mendija," which Linnaeus (2) included under " No. 404 Apocyno-nerium " and added a description. This " No. 404 " of Linnaeus, Trimen (12) says is the same as *Hunteria corymbosa* Roxb. Retzius (3) mentions " No. 72 *Cameraria zeylanica* " and refers to " Apocynonerium Linn. Fl. Zeyl. 404 " for the description of the plant. Retzius's name is valid and is the earliest specific name for this plant and therefore the present name should be *Hunteria zeylanica* (Retz.) Gardn.

Bulbophyllum maskeliyense Livera sp. nov.

Rhizoma elongatum, repens, ramosum, teres. Pseudobulbi concurrentes, disciformes, leviter longitudinaliter sulcati, virides, monophylli. Folium sessile, oblongum, apice retusum, supra sulcatum, subtus carinatum, marginibus recurvum. Scapus ad basin pseudobulborum erectus, 2-4 florus pedunculo pallide viridi, vaginis sese partim amplectentibus. Bracteae pedicello adpressae, ovatae, acutae, membranaceae, flavescentes. Flores foveoli, sepalis divergentibus. Sepalum dorsale lineari-lanceolatum, apice acutum, glabrum 4-nervia. Sepala lateralia falcata, 4-5 nervia, acuta. Petala parva, ovata, obtusa, 3-nervia gynostemio adpressa. Labellum parvum, carnosum, mobile valde recurvum, lingulatum, obtusum, bicarinatum ad margines. Gynostemium truncatum, apice tridentatum, falcatule decurvis. Pollinia 4, ovalia. Stigma profunde excavatum, obtriangulum. Pes gynostemii longus, linearis. Ovarium obconicum 6-sulcatum.

Roots fibrous, long. Pseudobulbs naked, 0.4-0.6 cm. in diameter. Leaves on the apex of the pseudobulb, apex retuse unequal, margins entire, surface shining above and dull below. Leaves tough, leathery

1.2-2 cm. long, 0.4-0.7 cm. broad. Scape 1.8-2.5 cm. long. Bracts minute. Flowers about 0.2 cm. long. Dorsal sepal 0.5 cm. long, 0.15 cm. broad. Lateral sepals 0.5 cm. long, 0.2 cm. at the broadest part. Petals 0.25 cm. long, margins crisped. Column winged. Lip fleshy, folded back on the column, which is much shorter than the lip.

Maskeliya, August. S.B. Stedman

Curcuma domestica var, **purpurea** Livera var. nov.

In July, 1919, at the request of Dr. Valeton of Java, a collection of *Curcuma spp.*, grown in Ceylon as Turmeric, was made by Mr. T. Petch. Among them was a plant with an immature inflorescence, its coma bracts differing from those of the ordinary *C. domestica* val.. in having their upper parts a deep purple instead of white. Though the rhizome was planted out the inflorescence did not develop further. Last year, however, the plant flowered again and a closer examination of it revealed the several other points, tabulated below, in which it d ffered from *C. domestica* Val. The characters noted under *C. domestica* are from Valeton's (13) description of that species :—

C. domestica Val.	*C. domestica* var. *purpurea*.
1. Leaves oblong-lanceolate, 3.5 times longer than broad.	Leaves elliptic-lanceolate, 2.3 times longer than broad.
2. Bracts with acute tips, white or green, 5-6 cm. long, 2.4-2.7 cm. broad.	Bracts with obtuse tips, purple spotted, 4-5 cm. long, 3 cm. broad.
3. Coma bracts conspicuously mucronate, wholly white only with few very fine scattered brown spots near the tip.	Coma bracts not mucronate, upper half of a deep purple.
4. Flowers protruding beyond the edge of the bracts.	Flowers included within the bract.
5. Staminode falcate.	Staminode not falcate.

C. domestica var *purpurea* is also characterised by its smaller flowers

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EXPLANATION OF PLATES

PLATE I

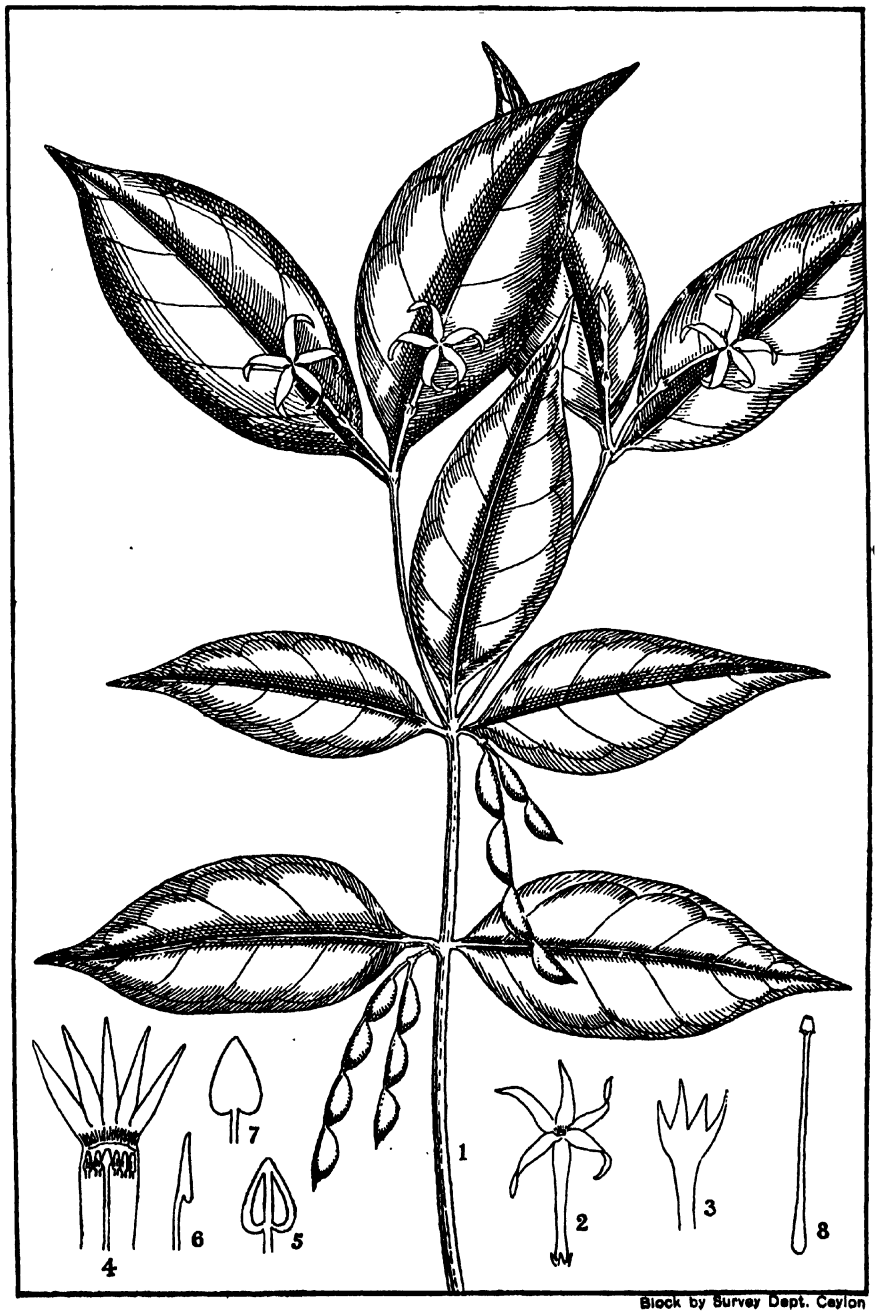
Petchia Ceylanica Liv.

1. Branch of the plant.
2. Flower.
3. Calyx opened out.
4. Corolla tube opened out.
5, 6. and 7. Front, side, and back view of anther.
8. Gynaecium.

PLATE II

Hunteria Legocii Liv.

1. Branch of the plant.
2. Flower.
3. Upper view of corolla.
4. Corolla tube opened out.
5, 6, and 7. Front, side, and back view of anther.
8. Gynaecium.
9. and 10. Longitudinal and transverse sections of the ovary.
11. Fruit.
12. and 13. Longitudinal and transverse sections of fruit.



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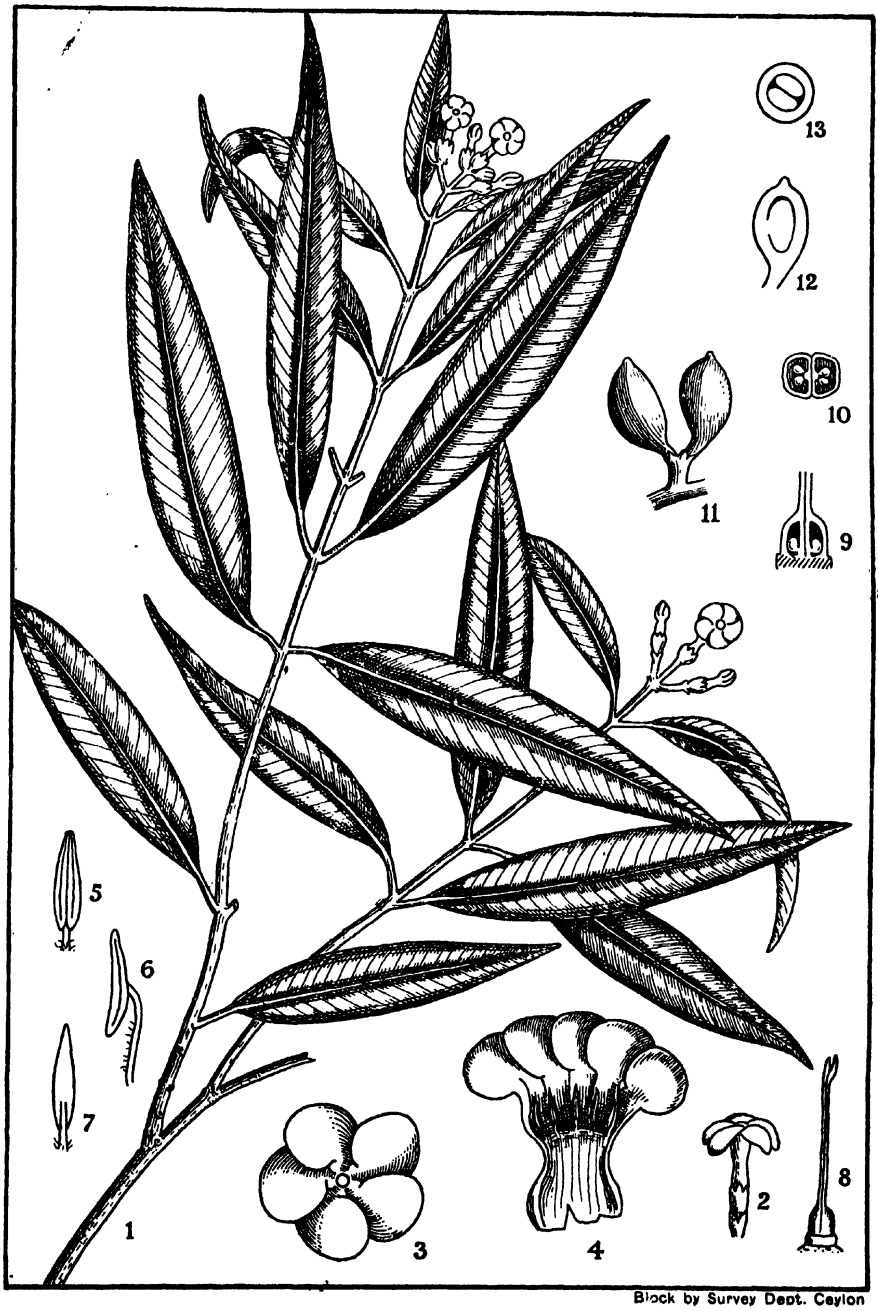

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Aeginetiaceae
A New Natural Family of Flowering Plants

BY

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Having for some time past been occupied with the study of that group of plants, included under the *Orobanchaceae* by Trimen (23), and their Indian allies, I felt that they occupy an anomalous position among the *Orobanchaceae* proper. I therefore extended my study to all the known species of *Aeginetia*, *Christisonia*, *Campbellia*, and *Hyobanche* and found that these genera form by themselves a natural group possessing characters which separate them sharply from the *Scrophulariaceae* on the one hand and the *Orobanchaceae* on the other. With the exception of *Aeginetia* the other genera here mentioned have been placed in more than one family by several botanists. As an enquiry into their history was of assistance to me in grouping them together under the new family proposed I give it in brief.

Aeginetia was founded by Linnaeus (1) who later (3) reduced it to a synonym of *Orobanche*; Roxburgh (4) however restored it. Gardner (15) established the genus *Christisonia* as one of the tribe *Cyrtandreae* (*Gesneraceae*) and Wight transferred it to the *Orobanchaceae*. Wight (17) also established a new genus *Campbellia* which he considered distinct from *Christisonia* on account of its bracteolate flowers and one-celled anthers. Of the two species *Campbellia cytinoides* Wt. and *C. aurantiaca* Wt., the former has an ovary which is bi-locular in the lower part and uni-locular in the upper, while the latter has a bi-locular ovary with a perforation in the upper central part of the septum. Hooker (21) p. 321 examined the former species and reduced the genus to *Christisonia*; Bentham (20) p. 967 examined the latter, retained the genus, and transferred it to the *Scrophulariaceae*. Bentham (20) p. 968 also transferred Thunberg's genus *Hyobanche* to the *Scrophulariaceae*, but Endlicher (10), Presl (15), Wight (17), Walpers (18), and Hooker (11) regarded it as a genus of *Orobanchaceae*.

It is very probable that the genus *Harveya* Hooker (9) belongs to this new family. Hooker (9) says: "It has the habit of the *Orobanchaceae* and it may be included among the imperfectly described species of *Orobanche* of Thunberg: but the structure of the ovary forbids its being united with that family." The limits of the family now proposed admits of the inclusion of this genus, which has one anther cell empty and subulate-acuminate. The capsule is, however, loculicidal.

The main points of difference between the *Orobanchaceae*, the *Scrophulariaceae*, and the *Aeginetiaceae* are shewn below:

Aeginetiaceae.	*Orobanchaceae.*	*Scrophulariaceae.*
Parasites with leaves reduced to scales.		Non-parasitic. (I)
Anther, one cell fertile.	Both cells fertile.	Both cells fertile. (II)
Spur, an outgrowth of the connective or a barren anther cell.	Absent, but base of anther mucronate.	Usually absent; when present (III) an outgrowth from the anther cell and not as in the Aeginetiaceae.
Ovary, one-celled or imperfectly two-celled.	One-celled.	Perfectly two-celled.
Placentae 2	4	2 (IV)
Fruit, dehisces septifragally.	Septifragally.	Septicidally or loculicidally. (V)

(I) The monotypic genus *Tozzia* L. is parasitic; *Rhinanthus* L. is also a more or less parasitic genus. Some species of *Alectra* Thunb. and of *Striga* Lour. are parasites with their leaves reduced to scales. *Cycnium tubulatum* Benth. has scales instead of leaves. The leaves of *Russelia* Jacq. are often scaly. The species of *Monttea* Gay have their leaves at times reduced to scales. (II) *Buttonia* Mc.Ken., *Sopubia* Ham., and *Graderia* Benth., have one anther cell barren but not reduced to a spur. (III) The species of *Centranthera* R. Br. have their anthers transversely spurred a ttheir bases. The loculus of the posterior anthers of some species of *Euphrasia* L. have long spurs. (IV) *Limosella* L. has its ovary shortly 2-locular at the base and 1-locular above owing to the disappearance of the septum above. *Glossostigma* Am. has either a 2-locular or a sub-1-locular ovary owing to the disappearance of the septum at the margins. (V) *Anarrhinum* Desf. and *Galvesia* Juss. have irregular dehiscence starting from a pore. *Schweinfurthia* Braun has a fragile pericarp.

The *Aeginetiaceae* like the *Orobanchaceae* are all parasitic plants whose vegetative parts are of a modified type of plant-structure, consisting principally of a branching, subterranean, rhizome-like structure which perennates from year to year on the roots of *Gramineae* or *Strobilanthes* which they intertwine and penetrate. These roots form a complete network by the fusion of adjacent parts. The point of attachment of the parasite to the host where the haustoria arise are usually swollen to a slight extent. In some species root tubers are formed at these points and from them root branches and stems grow out in various directions. These tubers, therefore, seem to serve as storehouses for the nutrition of the plant. The haustoria arise exogenously and the lateral

roots and stems endogenously from the parent root. The aerial parts grow very rapidly and in some cases are shed and the fruits and stems decay within a fortnight. The stems are usually very short and slender and rather brittle, varying from a white or cream to a purple or dark-red colour. They all turn black on drying. The leaves are represented by scales of varying sizes which are usually crowded towards the bases and more distant towards the apices of the stems. The inflorescences are racemose of various types, the corymbose and capitulum forms being the commonest. The flowers are ebracteolate or bibracteolate. The calyx is usually tubular, that of *Aeginetia* ranging from spathaceous to tubular-spathaceous. The corolla is gamopetalous and irregular. The structure of the anther is the chief distinguishing feature of this family. Of the two anther cells one only is fertile, the other either wanting as in *Campbellia* or in the form of a spur as in *Cliffordia*. The spur is also an outgrowth from the connective in *Aeginetia* and *Christisonia*. The ovary is one-celled in *Aeginetia*, *Christisonia*, and *Cliffordia*. It is partly 2-celled in *Campbellia* and completely 2-celled with a perforation in the upper portion of the septum in *Legocia*. In *Hyobanche* it is 2-celled, may-be by the fusion of the two parietal placentae. All have fruits with thin pericarps which turn mucilaginous and the seeds are then distributed by water. The seeds are albuminous with a reticulated hyaline testa. All these parasites are found in damp dark situations. Those found in situations with more light tend to develop a purple colour and those in darker places are yellowish or white. There are thus associated with the habitat of these parasites their colour, the mode of dehiscence of their fruit, and the distribution of their seeds.

This family ranges from Japan, the Philippine Islands, China with Cochin China, Java, Siam, the Malay Peninsula, and Burma to India and Ceylon where most of the species are found. The genus *Hyobanche* is restricted to South Africa. The original home of the family seems to have been in India.

This family is connected with the *Scrophulariaceae* through the genera of the tribe *Gerardieae* especially *Harveya* Hook., *Alectra* Thunb., *Buchnera* L., *Striga* Lour., and *Cycnium* E. Mey. also shew relationships with this family. The *Orobanchaceae* are related to this family through *Boschniakia* C. A. Mey. and *Lathraea* L.

THE GENERA AEGINETIA AND CHRISTISONIA

The genus *Aeginetia* was founded by Linnaeus (1) to receive one species, *Aeginetia indica*, which was published in his Species Plantarum (2). He, however, reduced it to a species of *Orobanche* (3), describing it as "*Orobanche* (*Aeginetia*) *caule unifloro, flore spathaceo.*" This genus

was restored by Roxburgh (4). The generic characters as given by Willdenow (5) are "*Aeginetia* Cal. 1-phyllus spathaceus. Cor. campanulata bilabiata. Capsula multilocularis." This last character is not true of *Aeginetia indica* L., which has a unilocular capsule.

Wallich (7) added the second, *Aeginetia pedunculata*, and third species (8) *Aeginetia abbreviata* Ham. to the genus. Walpers (12) added the fourth, *Aeginetia acaulis*, and at the time Reuter (14) monographed the genus four species were known. Miquel (19) referred *Centronia mirabilis* Bl. (6) to the genus as *Aeginatia Centronia*, thus making a fifth species of the genus.

These five species agree in the following respects:—

They are leafless herbs, the leaves being reduced to scales. Stem very short or none. *Aeginetia pedunculata* alone has a long stem. Flowers large, stalked. Bract one scale to a peduncle. Bracteoles none. Calyx spathaceous anteriorly split to the base, posteriorly acute, entire or minutely toothed; irregularly bifid in *A. acaulis*. Corolla tubular-campanulate to infundibuliform, wide, curved or not. Limb bilobed or not, lobes 5 spreading, 2 posterior connate. Stamens included didynamous; anthers united dehiscing along their lengths and spurred, the spur being an outgrowth from the connective. Ovary 1-locular with 2 parietal irregularly lobed placentae, not united at the centre. Style bent at the apex. Stigma peltate, dilated and lobed. Capsule sub-2-valved. Seeds minute.

It will be seen that the Linnean limits of this genus have been widened to receive the other species which were added later.

Gardner (15) established a new genus *Christisonia* to receive seven species and p. 154 says: "Besides the three species which I have been able to describe from recent specimens I believe I can give sufficiently good diagnostic characters of two other Ceylon ones from the figures above referred to; and in my herbarium I find excellent specimens of a sixth species from the Neilgherry Mountains in the Peninsula of India, which I owe to the kindness of Dr. Wight. To these I add *Phelipaea subacaulis* of Bentham (Scrop. Ind. p. 55.), which, judging from the description, is evidently a congener." *Phelipaea subacaulis* Benth. has all the characters, enumerated above, common to the five species of *Christisonia*, but its calyx differs innot being quite spathaceous, but two-lipped and tubular-spathaceous. This is only a difference in degree. Trimen, (18) in a note on this plant, says: "The species is, perhaps, equally well placed (as by Thwaites) in *Aeginetia* and is certainly allied to *A. pedunculata*, thus connecting the two genera. A closer examination of this plant and a comparison, tabulated below, with the other six species of *Aeginetia* revealed that this plant really belongs to this genus (*Aeginetia*) to which I have therefore transferred it.

Table I.

Ebracteolate.	*Corolla.* Upper.	Lower.	*Anthers.*	*Dehiscence of Anthers.*	*Spur.*	*Stigma.*
Aeginetia indica L.	not 2-lipped.		United.	Longitudinal.	Outgrowth of connective.	Lobed.
Aeginetia pedunculata Wall.	2 larger.	3 smaller.	United.	Longitudinal.	Outgrowth of connective.	Lobed.
Aeginetia Trimenii Liv.	2 smaller.	3 larger.	United.	Longitudinal.	Outgrowth of connective.	Lobed.
Aeginetia acaulis Walp.	2 smaller.	3 larger.	Not known. (I)	Longitudinal.	Outgrowth of connective.	Lobed.
Aeginetia Centronia Miql.	2	3	United.	Not known (II).	Outgrowth of connective.	Lobed.
Aeginetia abbreviata Ham.	2	3	Not known. (III)	Not known. (III)	Not known. (III)	Not known. (III)
Christisonia subacaulis Gardn.	2 smaller.	3 larger.	United.	Longitudinal.	Outgrowth of connective.	Lobed.

(I), (II) and (III) are unknown, but it is very probable that they are in agreement with the characters of the other species tor Miquel (19) pp. 712 and 713 included them under *Aeginetia*, giving among the generic characters—"Antherae coalitae, staminum inferiorum postice in calcar conicum productis."

The two genera *Aeginetia* and *Christisonia* are not, however, connected by this species, for as shown in Table 2 the species of *Christisonia* are further distinguished by having (1) a truly tubular calyx; (11) anthers which do not dehisce longitudinally but open by a pore.

It will be seen in table I that I have made a new species *Aeginetia Trimenii*. This plant was described by Trimen (23) as *Aeginetia pedunculata*. The numerous points of difference between the two species are shewn below :—

	Aeginetia Trimenii.	*A. pedunculata.*
1.	Roots fibrous.	Roots tuberous.
2.	Stem 1-2 in., widened upwards and branched.	Stem 2-3 in., subcylindric, simple.
3.	Scales entire.	Scales emarcescent.
4.	Pedicels 1-15 in. long.	Pedicels 1-4 in. long.
5.	Bracts 0.5-1 in. long.	Bracts 0.25-0.5 in. long.
6.	Calyx swollen at the base.	Calyx narrowed at the base.
7.	Corolla not contracted at the base.	Corolla contracted at the base.
8.	Corolla lobes rounded.	Corolla lobes reniform.
9.	Upper lobes of corolla smaller	Corolla lobes almost equal.

	Aeginetia Trimenii.	*A. pedunculata.*
10.	Filaments slightly pubescent.	Filaments glabrous.
11.	Spurs flattened.	Spurs subconic.

These two species also differ in colour.

I have also restored to specific rank *Aeginetia acaulis* Walp. and *Aegineta abbreviata* Ham. which have hitherto been regarded as synonyms of *A. pedunculata* Wall. but from which and from each other they differ abundantly. I have made the new combination *Aeginetia mirabilis* (Bl.) in compliance with Art. 48 of the International rules (24).

Gardner's species of *Christisonia* fall into two groups, viz. those with two bractlets and those without bractlets. Tables II and III. shew that the ebracteolate species are also characterised by having (I) the two upper corolla lobes differing in size from the three lower ones; (II) the anthers united; (III) the spur an outgrowth from the connective; (V) lobed stigmas, while the bibracteolate species have (I) the four upper lobes differing in size from the solitary lower lobe; (II) the anthers free; (III) the spur a barren anther cell; (IV) stigmas not lobed but clavate.

Table II.

Ebracteolate.	*Corolla.* Upper.	Lower.	*Anthers.*	*Dehiscence of Anthers.*	*Spur.*	*Stigma.*
Christisonia tubulosa Benth.	2 smaller.	3 larger.	United.	Pore.	Probably outgrowth of connective (I).	Lobed.
Christisonia Hookeri Clarke.	Not known (II).		Not known (II).	Not known (II).	Outgrowth of connective.	Lobed.
Christisonia Lawii Wight.	Not known (III).		Free in Wight's fig.	Pore.	Anth. cell in Wight's fig.	Lobed.
Christisonia calcarata Wight.	2 larger.	3 smaller.	Free in Wight's fig. (IV)	Pore.	Outgrowth of connective.	Lobed.
Christisonia tricolor Gardn.	2 smaller.	3 larger.	United.	Pore.	Outgrowth of connective.	Lobed.
Christisonia grandiflora Gardn.	2 larger.	3 smaller.	United.	Pore.	Outgrowth of connective.	Lobed.
Christisonia Thwaitesii Trim.	2 larger.	3 smaller.	United.	Pore.	Outgrowth of connective.	Lobed.

(I) Wight (17) describes the anthers of *Oligopholis tubulosa* (*Christisonia tubulosa* Benth.) as "anthers 2-celled, 1 fertile; the other sterile subulate." This subulate process looks very much like the outgrowth of the connective.

The full description of (II), (III) and (IV) are wanting, but the fact that they are ebracteolate and that the majority of the characters known about them agree with those of the other species in this table, justifies their inclusion here.

Table III.

Bi-bracteolate.	*Corolla.*		*Anthers.*	*Dehiscence of Anthers.*	*Spur.*	*Stigma.*
	Upper.	*Lower.*				
Christisonia bicolor Gardn.	4 larger.	1 smaller.	Free.	Pore.	Barren anther cell.	clavate, not lobed.
Christisonia pallida Gardn.	4 larger.	1 smaller.	Free.	Pore.	Barren anther cell.	clavate, not lobed.
Christisonia spectabilis Thw.	4 larger.	1 smaller.	Upper free, lower united. (I)	Pore.	Barren anther cell.	clavate, not lobed.
Christisonia aurantiaca Wt.	4 larger.	1 smaller.	Free.	Pore.	Barren anther cell.	umbellicate, not lobed.
Christisonia unicolor Gardn.	Gardner's description from a poor drawing.					
Christisonia zeylanica Liv. (II)	4 larger.	1 smaller.	Free.	Pore.	Barren anther cell.	rounded, not lobed.

(I) Perhaps the lower anthers are free and represented too close together in the figure. (II) The bractles are neither represented in the drawing nor are they discernible in the specimens which are too dry to shew them; the other characters, however, agree with those of the other species in this table.

The ebracteolate group includes *Christisonia grandiflora* and *Christisonia tricolor* which were the first and second species described by Gardner (15), and these were two of the three actual specimens on which he based the genus *Christisonia*. They also possess the characters described by Gardner (15) for that genus. I have, therefore, regarded them as the types of *Christisonia* and confined that name to the group in table II. I have given *Christisonia grandiflora* Gardn. specific rank in table II, only for bringing out the points of similarity in that group more forcibly; I have treated it as a variety in the enumeration of the several species.

In view of the several points of difference between the ebracteolate and bibracteolate species of *Christisonia* I have generically separated the latter group and called it *Cliffordia* after Sir Hugh Clifford —our present governor, who was the first patron of the Ceylon Natural History Society, to whom and to Lady Clifford I have the honour of dedicating it. In order to bring out more forcibly the characters of this group I have in table III regarded *Christisonia pallida* Gardn. as a species, but I have enumerated it as a variety of *Christisonia bicolor* Gardn. with which it is connected by intermediates. Petch (25) p. 696 says: "*Christisonia bicolor* var. *spectabilis*, differs from *Christisonia bicolor* in its rhizome, its narrower calyx and corolla tube, its glabrous calyx, and its lunate stigma. *Christisonia bicolor* has a more or less reniform stigma, that of var. spectabilis is laterally elongated and decurved at the ends, resembling to some extent a croquet hoop. In some of the herbarium specimens of the latter the stigma is a centimetre from side to side.

This should be separated from *Christisonia bicolor* as *Christisonia spectabilis* Thwaites. Hooker (21) reduced *Christisonia aurantiaca* Wt. (17) t. 1486 to a synonym of *Christisonia bicolor* Gardn., but the former has (I) scales glabrous ; (II) flowers corymbose ; and (III) long pedicelled; (IV) calyx teeth mucronate; (V) corolla tubular; (VI) stigma large hairy, umbellicate, while the latter has (I) scales pubescent; (II) flowers racemose, and (III) sessile or shortly pedicelled ; (IV) calyx teeth acute but not mucronate; (V) corolla infundibuliform ; (VI) stigma reniform. I have therefore regarded *Christisonia aurantiaca* Wt. as a distinct species. I have placed *Christisonia unicolor* Gardn. in this group, but unfortunately the full description of this plant is not available. Trimen (22) p. 240 says : " as no specimens corresponding with this figure (on which Gardner based his *Christisonia unicolor*) exist, *C. unicolor* Gardn. must ever remain indeterminable. I have also separated a new species, a drawing and specimens of which are in the Peradeniya Herbarium under *Christisonia Thwaitesii* Trim. This species, however, differs from *C. Thwaitesii* Trim. as shewn below :

	C. zeylanica.	*C. Thwaitesii.*
I.	Roots wiry.	Roots coral-like.
II.	Scales ovate, acute.	Scales rounded, obtuse.
III.	Flowers all crowded together in a head on a short stem.	Flowers racemose, distant on an elongated stem.
IV.	Calyx 0.75 in. long, tubular, lobes shallowly cleft.	Calyx 1-1·5 in. long, semispathaceous, deeply 2-lipped ; upper 2 toothed, lower 2-cleft.
V.	Corolla 2-lipped, upper 4 lobes larger than the lower one.	Corolla 2-lipped, upper two lobes smaller than the three lower ones.
VI.	Corolla tube erect, campanulate.	Corolla tube curved, infundibuliform.
VII.	Corolla lobes with entire margins.	Corolla lobes with fimbriate margins.
VIII.	Anthers free, dehiscing longitudinally.	Anthers united, opening by a pore.
IX.	Spur a barren anther cell.	Spur an outgrowth from the connective.
X.	Filaments of almost equal lengths.	Filaments upper longer.
XI.	Stigma not lobed but circular.	Stigma lobed, the two lobes, together forming a reniform plate.

THE GENUS CAMPBELLIA

Wight (17) instituted the genus *Campbellia* for two South-Indian species of *Orobanchaceae*. The chief generic characters are (1) stamens didynamous anthers one-celled opening by a pore at the apex ; (2) style simple, stigma capitate ; (3) ovary spuriously two-celled at the base one-celled at the apex, placentation parietal ; (4) calyx bibracteolate. Wight's generic description (17) is based on *Campbellia cytinoides*, but from the order of publication *Campbellia aurantiaca* is the type species of the genus *Campbellia*. The comparison tabulated below shows how the two species of *Campbellia* differ.

		Campbellia cytinoides.	*C. aurantiaca.*
Corolla.	Upper.	4 large.	4 large.
	Lower.	1 small.	1 small.
Anthers.		Free, not didynamous.	Free, didynamous.
Anth.-cells.		One.	One.
Dehiscence.		Porous.	Longitudinal.
Spur.		None.	Outgrowth of connective.
Ovary.		One locular at apex. two locular at the base.	Two-locular.

I consider the four points of difference of sufficient importance to separate them generically. I have, therefore, created another new genus *Legocia* which I have great pleasure in dedicating it to Father Legoc, who needs no introduction to Ceylon Botanists.

Aeginetiaceae Liv. fam. nov. Ord. Personales.

Herbae aphyllae, albae v. purpurae, ad radices parasiticae, basi saepius incrassatae squamisque imbricatis obtectae. Caules seu scapi e basi squamifera erecti, breves v. elongati, simplices v. parum ramosi, squamis alternis dense confertis v. dissitis, superioribus floralibus bracteiformis. Flores ad axillas bractearum solitarii, sessiles v. pedunculati, pauci v. in spicam densam terminalem conferti, v. in inflorescentiam centripetam dispositi, bracteolis 2 sub calyce v. ebracteolati. Flores hermaphroditi, irregulares. Calyx inferus gamosepalus, 4-5-dentatus v. antice v. postice fissus, spathaceus loborum aestivatione aperta. Corolla gamopetala, tubo cylindraceo ventricoso v. superne ampliato, recto v. saepius incurvo ; limbus oblique patens v. plus minus 2-labiatus, lobis 5 saepius latis imbricatis posticis interioribus. Stamina 4 didynama v. aequalia. infra medium tubum corollae affixa, lobis alterna, saepius inclusa filamentis parum incrassata. Antherae sub apice tubi conniventes v. liberae, dorsifixae ; loculus alter antherarum omnium

cassus late clavatus. Discus hypogynus obscurus v. latam brevemque productus, nec in eodem genere constans. Ovarium superum, lata basi affixum, 1-loculare, carpellis 2 compositum v. imperfecte 2-loculare placentis parietalibus v. septo adnatis. Stylus terminalis, simplex, stigmate dilatato orbiculato peltato v. in lobos 2 diviso, supra papilloso, placentis 2 ovulis numerosis fere undique tectae. Ovula anatropa. Capsula saepius calyce inclusa, subglobosa, carnosa demum deliquescens. Semina numerosissima, minima, testa foveolata-reticulata. Albumen carnosum. Embryo prope hilum minutus, cotyledonibus indistinctis.

Key to the genera.

Ovary 1-locular.	
Anthers united.	
Anthers dehiscing along their length.	1. Aeginetia.
Anthers opening by a pore.	2. Christisonia.
Anthers free.	3. Cliffordia.
Ovary 2-locular below and 1-locular above.	4. Campbellia.
Ovary 2-locular with a perforation in the upper central portion of the septum.	5. Legocia.
Ovary perfectly 2-locular.	6. Hyobanche.

I. AEGINETIA

Linn. Syst. ed. I. (1755).

Centronia Blume Bijdr. 776 (1826). *Tronicena* Steud. Nom. ed. 2 11. p. 721(1841). *Centronota* DC. ex Meissn. Gen. p. 303 (213) (1840): et Prodr. ix. p. 286 (1846). *Gasparinia* Endl. Gen. p. 1408 (1840).

Aeginetia indica Linn. Sp. Pi. ed. i. p. 632. Roxb. Cor. Pl. 1. p. 63, t. 91 ; Roxb. Fl. Ind. iii. p. 30 ; Reuter in DC. Prodr. xi. p. 43 ; Wall. Cat. 3964; Benth. Scroph. Ind. p. 55; Wight. III. t. 158b, f. 5 ; Wight. Icones. t. 895 ; Dalz. & Gibs. Bomb. Fl. p. 202 ; Griff. Ic. Pl. Asiat. t. 423; Thw. Enum. Pl. Zeyl. p. 221 ; Hooker in Fl. B. Ind. iv. p. 320 ; Trimen Fl. Ceyl. iii. p. 261. *Orobanche Aeginetia* Linn. Sp. Pl. ed 2. p. 883. *Tsiam-cumula* Rheede Hort. Malab. XI, p. 97, t. t. 47.

Distribution. India, Ceylon, Burma, China, Japan, Philippine Islands, and Malay Peninsula.

Aeginetia pedunculata Wall. Pl. As. Rar. iii. p. 13, t. 219 ; Reuter in DC. Prodr. xi. p. 43 ; Wight. I 11. t. 158b, f. 6; Wight Ic. t. 1421 ; Hooker in Fl. B. Ind. iv. p. 320 (exclud. syn.) *Orobanche pedunculata* Roxb. Hort. Beng. p. 45 ; Roxb. Fl. Ind. iii. p. 29.

Distribution. India, Cochin China, Java.

Aeginetia Trimenii Liv. sp. nov. *Aeginetia pedunculata* Trim. (non Wall.) in Fl. Ceyl. iii. p. 261 (1895) (exclud. syn.) Herba parasitica, erecta, 5-6 poll. alta, glabra. Caules divisi, crassi, erecti, rigidi, foliis viridibus destituti, squamis brevibus alternis ovatis acutis integris carnosis praediti. Squamae distantes, pauci. Flores pauci, 3-4 ut. videtur, cymosae dispositi, usque ad 1 poll. pedicellati, bracteis brevibus carnosis ovatis acutis basi vaginantibus suffulti. Calyx spathaceus, basi ventricosus, glaber, antice ad basin fissus. Corolla tubulosa, bilabiata, labio superiore minore. Stamina 4, inclusa, didynamia, filamentis brevibus; antherae lato-oblongae ; in staminibus longioribus antherae loculi ambo perfecti, in brevioribus unus perfectus, alter rassus connectivus in calcare longo productus. Ovarium ovoideum, uniloculare stylo apice inflexo superne stigmate magno transverso bifido minute glanduloso praeditum ; placentae duae, magnae, multipartitae undique ovuliferae.

Distribution. Ceylon.

Aeginetia abbreviata Ham. in Wall. Cat. n. 3965: Benth. Scroph. Ind. p. 45 : Reut. in DC. Prodr. xi. p. 43 : Walp. in Nov. Act. N. Cur. xix. Suppl. p. 400.

Distribution. India.

Aeginetia acaulis Walp. Repert. iii. p. 481 ; Reut. in DC. xi. p. 43. *Orobanche acaulis* Roxb. Fl. Ind. iii. p. 29. Pl. Cor. t. 292.

Distribution. India.

Aeginetia mirabilis (Bl.) Liv. comb. nov. *Centronia mirabilis* Bl. Bijdr. p. 776; R. Br. in Horsf. Pl. Jav. Rar. p. 122. *Gasparinia mirabilis* Endl. ex Zoll. in Nat. en. Genesk. Archief. ii. p. 7. *G. admirabilis* Hassk. Cat. p. 155. *Centronota mirabilis* DC. Prodr. ix. p. 268. *Aeginetia Centronia* Miq. Fl. Ind. Bat. ii. p. 713.

Distribution. Java.

Aeginetia subacaulis (Benth.) Liv. comb. nov. *Phelipaea subacaulis* Benth. Scroph. Ind. p. 55; Walp. Repert. Bot. Syst. iii. p. 463 ; Reut. in DC. Prodr. xi. p. 11: *Christisonia subacaulis* Gardn. in Calc. Journ. Nat. Hist. viii. p. 162 ; Hooker in Fl. B. Ind. iv. p. 321; Trimen Fl. Ceyl. iii. p. 262; *Campbellia subacaulis* Benth. in Gen. Pl. ii. p. 967.

Distribution. India, Ceylon.

Aeginetia siamensis (Craib) Liv. comb. nov. *Christisonia siamensis* Craib in Kew Bull. 1914, p. 129.

Distribution. Siam.

Aeginetia Saulierei (Dunn) Liv. comb. nov. *Christisonia Saulierei* Dunn in Kew Bull. 1914, p. 30.

Distribution. India.

Aeginetia Wightii (Elmer) Liv. comb. nov. *Christisonia Wightii* Elmer leaflets Philip. Bot. viii. 2793.

Distribution. Phillipine Islands.

Aeginetia Rodgeri (Sm. & Banerji) Liv. comb. nov. *Christisonia Rodgeri* Smith & Banerji in Records Bot. Surv. India vi., p. 30.

Distribution. Burma.

Aeginetia Scortechinii (Prain) Liv. comb. nov. *Christisonia Scortechinii* Prain in Journ. As. Soc. Beng. lxiii. 205.

Distribution. Malay Peninsula.

II. CHRISTISONIA

Gardn. in Calc. Journ. Nat. Hist. viii, p. 153. *Oligopholis* Wt.; Ic. iv. 5. t. 1422 (1850).

Christisonia tricolor Gard. l. c. p. 156. Thw. Enum. Pl. Zeyl., p. 222- Hooker in Fl. B. Ind., p. 323; Trimen Fl. Ceyl. iii., p. 263. var. *grandiflora* Hooker in Fl. B. Ind. iv., p. 323; Trimen Fl. Ceyl. iii, p. 264, *Christisonia grandiflora* Gard. l. c. p. 155. Thw. Enum. Pl. Zeyl. p. 221.

Distribution. Ceylon.

Christisonia calcarata Wt. Ic. t. 1426; Hooker in Fl. B. Ind. iv, p. 322. *Christisonia Stocksii* Hook. Ic. Pl. t. 836; Dalz. & Gibs. Bomb. Fl. 202.

Distribution. India.

Christisonia Lawii Wt. Ic. t. 1427; Dalz. & Gibs. Bomb. Fl. p. 202; Hooker in Fl. B. Ind. iv, p. 322.

Distribution. India.

Christisonia tubulosa Benth. in Gen. Pl. ii, p. 982; Hooker in Fl. B. Ind. iv. p. 321. *Oligopholis tubulosa* Wt. Ic. t. 1422 & II 1. t. 158b, f. 7.

Distribution. India.

Christisonia Hookeri Clarke ex Hooker in Fl. B. Ind. iv. p. 321.

Distribution. India.

Christisonia Thwaitesii Trimen in Journ. Bot. xxxiii. p. 40 & Fl. Ceyl. iii, p. 265.

Distribution. Ceylon.

III. CLIFFORDIA Liv. gen. nov.

Calyx tubulosus 5-dentatus, dentibus mucronatis v. latis obtusissimis aequalibus. Corollae tubus elongatus, rectus v. subincurvus, superne ampliatus: limbus bilabiatus, lobis 5 rotundatis, integris, 4 posticis altius connatis. Stamina 4 didynamia libera, inclusa v. breviter exserta: antherarum loculus alter perfectus poro dehiscens, alter cassus angustus subulato-acuminatus. Ovarium uniloculare placentis

2 magnis late 2-fidis v. sub-2-partitis, irregulariter dilatatis, undique ovuliferis : stylus apice inflexus stigmate dilatato v. clavate non lobato. Capsula perfecte 2-valvis. Semina numerosissima, minima, subglobosa, testa reticulata. Scapi breves, simplices, crassiusculi v. longiores tenuiruioresque ad apicem dense squarrosi, squamis ovatis. Flores magni, in scapo pauci, pedicellati, bibracteolatis.

Cliffordia bicolor (Gardn.) Liv. comb. nov. *Christisonia bicolor* Gardn. l. c. p. 160; Thw. Enum. Pl. Zeyl. p. 222. Hooker in Fl. B. Ind. iv. p. 322; Trimen in Fl. Ceyl. iii. p. 264. var. *pallida* (Gardn.) Liv. comb. nov. *Christisonia pallida* Gardn. l. c. p. 159. *Christisonia bicolor* var. *pallidiflora* Thw. Enum. Pl., Zeyl. p. 222 ; Trimen Fl. Ceyl. iii. p. 264.

Distribution. India, Ceylon.

Cliffordia spectabilis (Thw.) Liv. comb. nov. *Christisonia spectabilis* Thw. ex. Trimen in Journ. Bot. xxiii. p. 241. (1885). *Christisonia bicolor* var *spectabilis* Trimen in Journ. Bot. xxiii. p. 241 (1885) & Fl. Ceyl. iii. p. 264. *Christisonia albida* Trimen (non Thw.) in Fl. Ceyl. ii. p. 265.i

Distribution. Ceylon.

Cliffordia aurantiaca (Wt.) Liv. comb. nov. *Christisonia aurantiaca* Wt. Ic. t. 1486.

Distribution. India.

Cliffordia unicolor (Gardn.) Liv. comb. nov. *Christisonia unicolor* Gardn. l. c. p. 161.

Distribution. Ceylon.

Cliffordia zeylanica Liv. sp. nov.

Herba erecta, glaberrima. Caules simplices 0.3 in. crassi, squamis ovatis basin sparsis ad apicem densis obtectis. Inflorescentia densa centripeta ; pedicelli 0.5. in. erecti. Calycis glabri tubus 0.8 in., cylindricus, foveolatus ; dentes lati triangulares obtusi. Corollae tubus 1 in., cylindricus, albus ; limbi lobi 5 rotundati, paullo reflexi. Stamina brevitor exserta ; filamenta glabra. Ovarium 0.3 in. altum, ovoideum stylo exserto ; stigma peltatum rotundatum.

Distribution. Ceylon.

IV. LEGOCIA Liv. gen. nov.

Calyx tubulosus, 5-fid, lobis valvatis. Corollae tubus brevis erectus, superne ampliatus; limbus obliquus, 5-lobus, lobis patentibus rotundatis, 4 posticis majoribus. Stamina 4 didynamia, libera, tubo affixa, exserta, filamentis crassiuscule filiformibus ; antherarum loculus perfectus basi acutiusculus longitudinaliter dehiscens alter deficiens Ovarium perfecte 2-loculare septo perforato ad apicem, placentis in. utroque loculo geminis ; stylus elongatus apice inflexus, clavatus, stigmate dilatato capitato oblongo ; ovula numerosa. Capsula ovata, peri-

carpia fragilis demum deliquescens, Semina numerosissima, ovoidea, testa striata. Herba nana, crassa, carnosa, colorata, simplex, aphylla, squamis imbricatis obtecta. Spicae breves, terminales, pedicellis brevibus, 2-bracteolatis. Flores magni 2-bracteolatis.

Legocia aurantiaca (Wt.) Liv. comb. nov. *Campbellia aurantiaca* Wt. Ic. t. 1424. *Christisonia alibida* Thw. ex Hooker (ex parte) in Fl. B. Ind. iv, p. 323.

Distribution. India, Ceylon.

V. CAMPBELLIA

Wt. Ic. iv. part iii. p. 5 (1850) emended.

Calyx tubuloso-campanulatus, irregulariter 5-dentatus, dentis valvatis. Corollae tubus erectus; limbus obliquus 5-lobus, lobis patentibus rotundatis, 4 posticis majoribus. Stamina 4 non didynamia, libra, tubo affixa exserta; filamentis crassiuscule filiformibus; antherarum loculus alter perfectus poro dehiscens, alter deficiens. Ovarium basin 2-loculare apice 1-loculare placentis in utroque loculo geminis ; stylus elongatus, apice inflexus clavatus, stigmate dilatato oblongo ; ovula numerosa. Capsula ovoidea. Semina numerosissima testa laxe reticulata. Herba parasitica, nana, crassa, carnosa, colorata, simplex, aphylla, squamis obtectis. Racemi densi, breves, terminales, 2-bracteolatis. Flores magni, 2-bracteolatis.

Campbellia cytinoides Wt. l. c. p. 6, t. 1425; Trim. Fl. Ceyl. iii, p. 265. *Phelipaea cytinoides* Reuter in DC. Prodr. xi. p. 14. *Christisonia neilgherrica* Gardn. in Calc. Journ Nat. Hist. viii. p. 157; Hooker in Fl. B. Ind. iv. p. 322.

Distribution. India, Ceylon.

VI. HYOBANCHE

Linn. Mant. ii. p. 155 (1771). *Haematobanche* Presl, Epim. Bot. 249 (1850).

Hyobanche sanguinea Linn. Mant. ii. 253.

Distribution. South Africa.

Hyobanche atropurpurea Bolus in Hook. Ic. Pl. t. 1486.

Distribution. South Africa.

Hyobanche glabrata Hiern in Dyer's Fl. Cap. iv. ii. 417. *Haematobanche sanguinea* Presl, l. c.

Distribution. South Africa.

Hyobanche rubra N.E. Br. in Kew Bull. 1901. p. 129.

Distribution. South Africa.

Hyobanche robusta Schonland in Kew Bull. 1913. p. 301.

Distribution. South Africa.

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Revisions of Ceylon Fungi
Part VIII

BY

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343.—Mycena tenerrima Berk.

This species was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 127, from Thwaites 861. Recent specimens have been collected on decaying inflorescences of *Parkia Roxburghii*, and on dead bark scales on the trunks of living jak trees (*Artocarpus integrifolia*).

The pileus is 2-4 mm. diameter, campanulate or conico-campanulate, white, membranous, feebly sulcate at the margin, pruinose with loose subglobose, polyhedral, or ovoid cells, 20-40 μ diameter, which are sometimes densely covered with blunt spines, sometimes with scattered acute spines, up to 8 μ high, occasionally bifid. The stalk is usually 12-15 mm. long, sometimes up to 3·5 cm. long, 0·5 mm. diameter at the base, attenuated upwards, white, translucent, tomentose at the base, clothed with spreading white hairs, which are up to 150 μ long, 10 μ diameter, flexuose, equal, hyaline, minutely spinulose, rounded at the apex. The gills are white, rather broad, free, the outer edge bearing club-shaped cystidia, with a stalk about 30 μ long and 8 μ diameter and a globose (24-30 μ) or ovoid (30×24 μ) head, everywhere spinulose. The spores are oblong-oval, white, 8-10×4-5 μ.

Lange (Studies in the agarics of Denmark, Part I) states that in *Mycena tenerrima* the loose cells on the pileus are spherical or oval, densely warted; the cystidia minutely warted, somewhat variable, the apex either obtuse, obtuse with a hair-like appendage, or gradually tapering into a hair-like appendage: the hairs on the stem acute at the apex and somewhat inflated at the base ; the spores broadly ovate, 8-9·5×6-6·5 μ.

The Ceylon fungus appears to differ from *M. tenerrima* in microscopic details, especially as regards the cystidia. It also differs in not

having a basal disc. There are specimens with a basal disc in Thwaites 861 in Herb. Peradeniya, but they are another species, which has a thicker smooth stalk.

344.—Mycena clavulifer B. & Br.

This species was described from Thwaites 803 in Fungi of Ceylon, No. 126. The pileus was said to be beset with clavate stiff hairs. Recent examples have been collected on dead twigs, and on decaying inflorescences of *Parkia Roxburghii*.

The pileus is up to 5 mm. diameter, campanulate, becoming almost plane, white, with a brownish yellow spot in the centre, sulcate almost to the centre, covered with scattered, erect setae, minutely pruinose, margin fimbriate. The setae are up to 300 μ high, spear-shaped, cylindric and about 16 μ diameter below, with an oval head about 100 μ high and 36 μ broad, smooth; the wall is about 2 μ thick below, thinner above, and the contents are granular. The superficial hyphae of the pileus have free, spinulose tips, up to 10 μ long. The margin of the pileus bears cylindric or irregularly inflated hairs, up to 90 μ long, 18 μ diameter at the base, tapering to 14 μ at the apex, closely and strongly spinulose, the shorter hairs spinulose to the apex, the longer with a solid tip which is minutely warted. The stalk is hyaline, about 1 cm. high, 0·3 mm. diameter, clothed with the same setae as the pileus, and arising from a white radiating disc. The gills are white, ventricose, adnate, and the spores white, narrow-oval, 6×3 μ. In the specimens of Thwaites 803 in Herb. Peradeniya, the spores are broader, 8×5 μ; these specimens are on decaying palm tissue.

345.—Mycena paediscula B. & Br.

This species was described by Berkeley and Broome from Thwaites 828 in Fungi of Ceylon, No. 129, as "Candidus, minimus, pileo subgloboso sulcato; stipite capillari, lamellis adnatis. Pileus half a line across; stem 1 line high." Specimens have been collected recently on decaying inflorescences of *Parkia Roxburghii*.

The pileus is up to 5 mm. diameter, campanulate, obtuse or strongly umbonate, becoming plane, pale yellow, becoming white, membranous, glabrous, margin crenate, radially striate. The stalk is up to 1 cm. high, 0·3 mm. diameter, white, translucent, becoming pale brown, minutely pulverulent, sometimes with a few brown spreading fibrils at the base. The gills are pale yellow, then white, few, distant, arched, decurrent. The spores are white, narrow-oval, 5-8×3 μ.

Thwaites sent another collection and a figure of this species (No. 929), which was assigned by Berkeley and Broome to *Mycena citrinella* P.

It is a smaller and more delicate species than *M. citrinella*, less brightly coloured, with strongly decurrent gills, and the stalk not viscid. As it will revive after drying, it should probably be referred to *Marasmius*. In the part of Thwaites 828 in Herb. Peradeniya, the stalks are up to 6 mm. long.

346.—Mycena heliscus B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 128, from Thwaites 934, *cum icone*, as "Pileo hemisphaerico sulcato plumbeo stipiteque capillari albo pruinosis: lamellis paucis crassis adnatis. On dead twigs. Gregarious; pileus 1 line across, hemispherical, lead-coloured, deeply sulcate, pruinose; stem 1 inch high, white, thread-shaped, pruinose like the pileus; gills few, thick, white, adnate."

It has occurred during recent years on decaying stumps under bell glasses at the laboratory, Peradeniya. The pileus is up to 6 mm. diameter, at first hemispherical or campanulate, then convex or almost plane, membranous, at first French grey, then greyish white, darker in the centre, sometimes white from the first, sulcate to the centre, smooth, margin sometimes serrate. The stalk is up to 2·5 cm. long, filiform, 0·15-0·3 mm. diameter, white, subtranslucent, pruinose with white particles below, glabrous and shining above, equal or inflated at the apex, slightly inflated at the base, sometimes with a few white strigae extending over the substratum. The gills are white, becoming yellowish, distant, rather broad, rounded behind, adnate, or arcuate and decurrent on the larger, expanded specimens, of either one or two lengths, united behind over the apex of the stalk. The spores are narrow-oval, sometimes clavate, acute at one end, 7-9×3-4 μ.

The fungus is not readily putrescent, and revives if moistened after drying. It should presumably be referred to *Marasmius*. Berkeley and Broome cited Thwaites 944 for this species, but the figure is marked 934. Thwaites 944, in Herb. Peradeniya, is *Psathyrella furfurella* B. & Br.

347.—Mycena corticola Schum.

This species was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 127*, with the note, "a white variety with pale brown flesh." It was said to be Thwaites 1217, *cum icone*; but the figure 1217 is marked by Thwaites, "specimens not dried." Consequently the record was based on the figure only.

The figure shows six examples, evidently on a bark scale from a standing tree. The pileus is hemispherical or campanulate, up to 4 mm. diameter, sulcato-striate almost to the centre, grey in the centre, be-

coming white outwards. The stalks are white, curving upwards, 5 mm. high, 0·25 mm. diameter. The gills are ventricose, but it is not possible to say from the small figure of the section whether the artist intended them to be adnate or free.

Without specimens, it is impossible to decide what this species was. Specimens which appear to match the figure have, however, been collected on tree trunks at Peradeniya. In these the pileus is cylindric or campanulate, apex obtuse, rounded, up to 5 mm. diameter and 3 mm. high, margin crenate, greyish brown in the centre, becoming white outwards, feebly sulcato-striate almost to the centre, pruinose with white, spherical, spinulose cells, up to 50 μ diameter. The stalk is about 1 cm. high, 0·5 mm diameter, curved, white, translucent, minutely pruinose, with a white tomentose ring at the base. The gills are somewhat distant, broad, ventricose, adnate, pallid; they bear globose, shortly stalked cystidia, up to 20 μ diameter, which are covered with blunt spines up to 2 μ long. The spores are white, broadly oval, 6-8×4-6 μ. The fungus has an alkaline smell.

This species may be known as *Mycena dendrophila* Petch, n. sp. Type specimen, No. 4369, Peradeniya, December 13, 1914.

348.—Crepidotus epicrocinus B. & Br.

Fresh specimens of this species had not been found, when the Ceylon species of *Crepidotus* were re-described in Ann. Perad., IX, pp. 223-227. It was collected in March, 1925, on a fallen branch.

The pileus is sessile, attached almost laterally by white strigae, pale yellow, very minutely tomentose. The gills are pallid, becoming pale brown, ventricose, attenuated behind, moderately crowded. The spores are spherical, 4-6 μ diameter, rather coarsely warted.

The type figure shows radiating red streaks on the pileus. These were not present on the recent specimens.

349.—Psathyrella disseminata P.

In Ann. Perad., IV, p. 397, the writer pointed out that Berkeley and Broome divided Thwaites 942 into two species, one of which they assigned to *Psathyrella disseminata* P., while the other was described as a new species, *Psathyrella ctenodes* B. & Br. Paintings were furnished by Thwaites of both these forms. That assigned to *Psathyrella disseminata* shows a cylindrico-campanulate pileus, with a rounded apex, while that named *Psathyrella ctenodes* has the apex slightly umbonate. This variation occurs in the one species, and there can be little doubt that the two paintings represent the same species.

Because of certain supposed differences in microscopic details, Berkeley and Broome's name, *ctenodes*, was adopted for this species, and it was referred to *Psathyra*, as the spores are brown. The recent publication of a full description of *Psathyrella disseminata* by Buller (Researches on Fungi, vol. III) gave an opportunity of revising that determination, and as a result it appears that the Ceylon fungus should be referred to *Psathyrella disseminata*.

The pilocystidia, the spherical cells on the pileus, the cheilocystidia, and the caulocystidia are the same on the Ceylon fungus as those described and figured by Buller for *Psathyrella disseminata*. The pileus is plicato-sulcate almost to the centre, and the margin is more regularly crenate than appears in figures of *Psathyrella disseminata*. Coarse white, long-triangular strigae extend from the base of the stalk over the substratum; these are well shown in the type figure of *Psathyrella ctenodes*, and it was probably this feature which induced Berkeley and Broome to describe it as a new species.

The red strands described by Buller are well-developed in soil which has been thrown on the host stump. In Ceylon specimens they are reddish brown. It may be noted that in Ceylon this species will develop in its usual thousands on the upper side of stumps which have been dug up, and left lying with only two or three points in contact with the ground.

Buller describes the spores of *Psathyrella disseminata* as black in mass on white paper, but dark-brown when examined with the microscope, oval, 9-11×4-5 μ. In the Ceylon form, the spores are purple brown in mass, dark brown by transmitted light, 5-10×3·5-4·5 μ, oval, inequilateral.

350.—Coprinus setulosus B. & Br.

The original description of this species, in Fungi of Ceylon, No. 310, is "Pileo cylindrico campanulato obtuso usque ad discum striato setis fulvis undique obsito; stipite fistuloso candido sursum attenuato; lamellis angustissimis adnexis (No. 845, cum icone; No. 936)."

This species grows on dead wood or among dead leaves, etc. The pileus is at first cylindric, obtuse, then conico-campanulate, up to 2·5 cm. high. Frequently it is persistently cylindric. It is pale brown or reddish brown at first, then livid or greyish with a brown central disc, striate up to the disc, covered with erect, rigid, brown setae up to 0·4 mm. long. The stalk is up to 11 cm. high, 1·5-3·5 mm. diameter, white, shining, finely striate, fragile, hollow, somewhat thickened and yellowish at the base. The gills are ascending, adnexed, up to 4 mm. broad in large examples. The spores are subglobose, 8-10 μ, or ellipsoidal,

8×6 μ, and the cystidia, globose, 20-30 μ diameter. The setae on the pileus are pale yellow brown, with an elongated oval base about 12 μ diameter, attenuated upwards, straight, or slightly curved above, acute, thick-walled, usually not septate.

351.—Coprinus castaneus B. & Br.

Berkeley and Broome described this species, in Fungi of Ceylon, No. 311, as "Pileo digitaliformi pallide castaneo glabro; stipite sursum attenuato basi truncato glabro eximie fistuloso; lamellis angustis ascendentibus adnatis (No. 935, cum icone)."

This species has been found growing among dead leaves, and on decaying coconut buds, in the latter case from thick white plates and strands of mycelium between the leaf bases. In the former situation, it is up to 10 cm. high, with a pileus up to 2·5 cm. diameter; in the latter, up to 15 cm. high, with stalks up to 1 cm. diameter, and a pileus up to 7·5 cm. diameter.

The pileus is at first cylindric, obtuse, then almost plane, with a revolute margin, and plicato-sulcate almost to the centre. At first, it is densely clothed with long, white, silky or floccose scales, which disappear from the centre outwards, the pileus ultimately being smooth and brown in the centre, white (unexpanded) or hyaline (expanded) elsewhere, with a few scattered flocci. The gills are narrow, rather crowded, ascending, widely free on the larger specimens, but close to the stem on smaller, dry weather examples. The stalk is up to 15 cm. long, 4-10 mm. diameter at the base, strongly attenuated upwards to 1·5 to 5 mm., white, silky fibrillose below, becoming glabrous above, hollow, lined with shining white fibrils, white or brownish internally. The spores are purple black in mass, black by transmitted light, oval, somewhat inequilateral, slightly apiculate, 8-12×5-7 μ.

352.—Aecidium Chionanthi B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 857, as "Crassiusculum, congestum; pseudoperidiis incarceratis nec prominentibus, ore irregulari; sporis candidis rugosis. On leaves of *Chionanthus*. Forming rufous thick patches; spores ·001 long with little wrinkles." The Ceylon plants included by Thwaites in *Chionanthus* are now referred to *Linociera*. In Mon. Uredinearum, VI, p. 321, Sydow stated that *Aecidium Chionanthi* is the Aecidium of *Cystopsora Oleae* Butl., the host plant having been misnamed.

Examples have been collected recently on a variety of *Olea polygama*.

The aecidia occur on the inflorescence,—on the pedicels, calyx, and corolla, all of which are enlarged and thickened. They are brownish

yellow, hemispherical or pulvinate, 0·3 mm. diameter, clustered. There is no evident pseudoperidium, the aecidium being covered by a thin membrane, glabrous and somewhat varnished, consisting of the epidermis of the host plant. This cover becomes perforated at the apex by a small pore, but in the available specimens the aecidium does not open widely.

The spores are spherical, 16-20 μ diameter, or oval, 22-28×16-17 μ, or angularly globose or oval. The contents are orange, and the wall hyaline, 2 μ thick, covered with flexuose parallel ridges, either longitudinally or obliquely, which anastomose and form a network.

353.—Rosellinia catervaria (B. & Br.) Sacc.

This was re-described in Ann. Perad., VI, p. 175, from the type specimen. The perithecia in the type are up to 0·4 mm. diameter. In recent collections from Hakgala, which appear to be referable to this species, the perithecia are up to 0·8 mm. diameter; they are usually clustered, sometimes confluent, at first minutely adpressed tomentose, becoming glabrous and minutely rugose. In one case, the fungus grew on dead wood, and in another, on a decaying *Fomes*. The spores in all cases are rather pale brown or pale fuliginous, oblong, or ellipsoidal, with rounded ends, centrally guttulate, 8-12×3·5-4 μ.

Berkeley and Broome gave the length of the spore as 37·5 μ.

354.—Rosellinia rhypara (B. & Br.) Sacc.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 1106, from Thwaites 555, as "Peritheciis globosis coffeicoloribus sordidis, ostiolo minuto; ascis linearibus; sporidiis ellipticis utrinque attenuatis. On dead wood. Sporidia 22·5-25×10-12·5 μ."

There are two species in the specimen, Thwaites 555, in Herb. Peradeniya. One of them has spores, 20-28×10-14 μ, the other 11-15×7-9 μ. The former, which corresponds the more closely to Berkeley and Broome's description, is on bark. The latter, which is on dead wood, has been described as *Rosellinia albocincta* Petch, in Ann. Perad., VII, p. 300.

Rosellinia rhypara has superficial perithecia, scattered or clustered, black, globose, up to 1 mm. diameter, minutely adpressed tomentose, with a minute, conical ostiolum. The sporiferous part of the ascus is about 130×12 μ. The spores are black-brown, oval inequilateral, or cymbiform, 20-28×10-14 μ, ends obtuse, rarely slightly contracted and subapiculate.

355.—Aegerita candida P.

This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 908, from Thwaites 285, 349, "on sticks." The specimens are on bark. Thwaites 285 also provided a *Peziza*, which Berkeley and Broome assigned to *Dasyscypha hyalina* P.

The specimens are circular, up to 0·25 mm. diameter, discoid, about 0·1 mm. thick, with a slightly convex upper surface, creamy white, and soft. They appear glabrous, but are slightly pruinose when magnified. The base is flat and the margin rounded, or sometimes the lower edge of the margin is rounded and the upper edge somewhat rectangular. Over the sides and base there is a "cortical layer," composed of radial parallel cells, about 40 μ deep, which resemble the conidiophores; these are not fused laterally and are apparently barren conidiophores. The internal tissue is plectenchymatous, composed of thick-walled irregular hyphae, and resembles the context of a tremelloid fungus, but it is not hard and horny when dry. The upper surface consists of a palisade layer of parallel basidia, about 25 μ deep. The basidia are simple, or branched near the base, stout, about 4 μ diameter, thick-walled, septate, irregular, similar to those of *Aegerita candida*. They usually bear a single apical conidium, rarely two. The conidia are oval, 6-9×4-7 μ, with a wall 1-2 μ thick; when detached they apparently remain adherent to the sporodochium.

This species resembles *Aegerita candida* in its conidiophores, and is probably to be assigned to that genus, but it is not that species. It may be known as *Aegerita discoidea*.

356.—Isaria congesta B. & Br.

Berkeley and Broome described this species, in Fungi of Ceylon, No. 861, as "Brevis, clavata, cinerea, e basi communi oriunda; sporis tenuibus oblongis (No. 78). Spores 6·25 μ long. Probably the conidioid stage of some Sphaeria."

The clavae arise in clusters of up to fifty from an erumpent stroma, which is pale yellow and somewhat loose internally, with a thin black cortex. They form spreading tufts, some lying on the surface of the host, others erect or suberect. The colour is grey or greyish brown, pale brown by transmitted light, and the individual clavae are cylindric, equal or attenuated upwards, up to 1·25 mm. high, 0·1-0·15 mm. diameter, with an obtuse apex. The outer layer is firm, but the inner tissue rather loose. They are composed of longitudinal hyphae, the tips of which curve outwards and form a loose palisade layer. These tips are clavate, up to 3 μ diameter, minutely verrucose, acute above, sometimes dividing into two or more spreading points. These bear narrow-

oval or fusoid, hyaline, continuous, minutely warted conidia, 5-8×1-1·5 μ, usually acute, both terminally and laterally.

There is no doubt that this is a stage of a stromatic Sphaeria, though it has not been possible to correlate it with any known species.

357.—Periconia rigida B. & Br.

This was described in Fungi of Ceylon, No. 892, as "Setiformis, e fibris plurimis compacta apice clavatis basi radiatis; sporis oblongis uniseptatis uninucleatis (No. 250)." In Saccardo, Sylloge Fungorum, IV, p. 627, it was transferred to *Didymobotryum*.

The synnemata are up to 1 mm. high, rigid, black, slightly inflated and conoid at the base to a height of about 0·2 mm., 0·18 mm. diameter below, 0·06 mm. diameter above the basal swelling, expanding above into an ovoid head, 0·25 mm. high, 0·15 mm. diameter. The conidiophores are united up to the apex. The conidia are blackish-brown; oblong-oval or narrow oval, ends usually rounded, one-septate, sometimes slightly constricted, 10-16×4-6 μ. The type specimen is on bamboo.

This does not appear to differ from *Didymobotryum atrum* Pat., the conidia of which are given as 16-18×6 μ.

358.—Sporotrichum lichenicola B. & Br.

Berkeley and Broome described this, in Fungi of Ceylon, No. 916. as "Niveum, floccis erectis acutis; sporis oblongis apicalibus (No. 430). On lichens."

The plant forms minute, lax, white tufts, up to 0·2 mm. high, each composed of a few (up to six), erect or spreading, rigid, moniliform chains of cells, which branch dichotomously. In general appearance it resembles a minute coralline. The cells are oval, truncate at the ends, 22-26×16-20 μ, not separating, strongly encrusted with minute spherical granules which do not dissolve in hydrochloric or sulphuric acid.

If this is really a fungus it is a *Moniliopsis*.

359.—Fusarium pulvinatum (B. & Br.) Sacc.

This was described by Berkeley and Broome, in Fungi of Ceylon, No. 917, as *Fusisporum pulvinatum* B. & Br., "Eximie pulvinatum, pallidum, tomentosum; sporis curvulis elongatis triseptatis (No. 215). On bark. November, 1867." In Saccardo, Sylloge Fungorum, IV, p. 699, it was transferred to *Fusarium*.

The specimens are on the thin outer layer of the bark, which was evidently readily separable from the underlying tissue. They are flattened pulvinate, up to 4 mm. diameter and 1 mm. high, sometimes

arranged in rows. The surface is at first glabrous and nodular, but subsequently becomes tomentose or strigose with rather thick masses of coarse, intertwined, somewhat rigid hairs. When sectioned, the cushion is friable, and breaks up into coarse granules. Beneath each cushion, the bark is either elevated gradually in a convex blister, or grows out into a subglobose hollow structure, open at the base.

The context of the cushion is composed of thin-walled, irregular fibres, up to 16 μ diameter, which appear to be part of the host plant. The hairs are 6·10 μ diameter, minutely verrucose, regular, and resemble stout hyphae. They do not give the cellulose reaction with chlorzinc-iodide, nor the lignin reaction with phloroglucin.

The spores described by Berkeley and Broome have not been observed, and it would seem doubtful that they could have belonged to the cushions. Until fresh material has been collected, it would be unsafe to arrive at any conclusion concerning these specimens, but there appears to be a strong probability that they are a gall formation. The remains of mites are common among the hairs, but that may be accidental.

360.—**Psilonia penicillata** B. & Br.

Berkeley and Broome described this, in Fungi of Ceylon, No. 915, as "Nivea, e communi basi penicillata, apicibus inflatis; sporis minutis (No. 225). On leaves apparently of some palm. Spores 0·0001 long. Analogous to *Fusidium fasciculatum.*" In Saccardo, Sylloge Fungorum, IV, p. 689, it was transferred to *Volutella* as *Volutella penicillata* (B. & Br.) Sacc.

The fungus forms minute, white, obconic tufts, plentifully scattered over the host, and now generally lying flat in small fans on the substratum. They are 0·3-0·5 mm. high, 20-100 μ diameter at the base, expanding to a breadth of 300 μ at the apex, and are composed of diverging conidiophores which are sometimes more or less massed into a columella in the centre. The individual conidiophores are hyaline, somewhat rigid, thick-walled, closely septate above, 3-4 μ diameter below, the apical segment oval and expanding to 6 μ diameter. The conidia are borne on minute sterigmata in a ring below each septum, and at the apex, and are hyaline, oval, verrucose, 3-4×2·5-3 μ, or globose, 3·5 μ diameter. Frequently the sterigmata arise from a thickening of the wall, about 2·5 μ long and 1·5 μ high at one side of the conidiophore or at the apex.

The conidiophore and conidia of this species are identical with those of *Isaria pulcherrima* B. & Br. (Fungi of Ceylon, No. 863); and there is no doubt that it is a young or a reduced form of the latter species.

361.—Penicillium incarnatum B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 910, as "Pulvinulis minutis pallide carneis; floccis articulatis erectis hyalinis, apice digitatis; sporis limoniformibus (No. 241). On leaves of some Monocotyledon. Spores 0·0003 long."

The fungus is on a bamboo stem. It is erumpent, raising and cracking the epidermis in a minute oval scale, up to 0·3 mm. long and 0·15 mm. broad, the fungus appearing usually at one edge of the scale in a compact, pinkish, linear tuft, generally not more than 0·1 mm. high. The conidiophores are crowded, hyaline, stout, about 6 μ diameter below, sparingly branched above, the branches being about 4 μ diameter and forming a head about 40 μ high. The phialides are narrow-oval, 10-12 × 3 μ, three or four at the apex of each branch. The conidia are hyaline, oval, very minutely warted, 4-7 × 2·5-3·5 μ.

This species has not been collected again.

362.—Fusidium Crataevae B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 880, as "Niveum, minutum, floccis brevibus nodulosis; sporis clavaeformibus basi attenuatis (No. 512). On leaves of *Crataeva Roxburghii*. Peradeniya. February, 1868. Spores 0·002 long." In Saccardo, Sylloge Fungorum, IV, p. 27, the note is added "An *Heliscus*?"

The lower surface of the leaf, in the type specimen, is elevated in minute flattened tubercles, up to 0·3 mm. diameter, crowded together in patches up to 1 cm. diameter, on extensive brown discoloured areas. These tubercles are covered by a white network of hyaline hyphae, 4 μ diameter, which are most numerous between the tubercles. The hyphae bear solitary conidia, almost sessile, laterally. The conidia are hyaline, clavate or narrow flask-shaped, truncate at the base, strongly attenuated in the upper half, three septate in the lower half, 36-68 μ long, 6 μ diameter below, 3 μ diameter above, apex obtuse.

This appears to be a *Cercosporella*, and will stand as *Cercosporella Crataevae* (B. & Br.).

363.—Fusidium fasciculatum B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 879, as "Album, erectum, floccis fasciculatis saepe connatis; sporis oblongis (No. 142). Forming little white scattered tufts on bark. Spores 0·0006 long." In Fungi of Ceylon, No. 915, they described *Psilonia penicillata* B. & Br., and stated that the latter was analogous to *Fusidium fasciculatum*.

The specimens of *Fusidium fasciculatum* are on a dead twig and are in poor condition, apparently weathered. They are the same as *Psilonia penicillata* B. & Br., i.e., they are a reduced form of *Isaria pulcherrima* B. & Br. Spores 15 μ long have not been found; this measurement appears to be that of the terminal segment of the conidiophore.

364.—Penicillium roseum Link.

This species was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 911, on *Hibiscus*. No Thwaites' number was cited, the specimen having been sent by him in 1850.

The leaf bears minute, powdery, or somewhat byssoid, pink patches. These bear one-septate spores and are evidently not *Penicillium*. The conidiophores are 2-3 μ diameter below, dividing irregularly into finer branches above, and bearing branched chains of conidia, terminally and laterally. The conidia are hyaline, narrow-oval, one-septate, ends acute, 5-7×2-3 μ. This appears to be a *Hormiactis*, though the conidiophore is not simple and regular, as described for the type of that genus. It may be known as *Hormiactis rosea*.

Hormiactis rosea Petch, n. sp. Forming minute, powdery, pink patches; conidiophores hyaline, 2-3 μ diameter below, dividing irregularly above into finer branches; conidia in terminal or lateral branched chains, hyaline, narrow-oval, one-septate, ends acute, 5-7×2-3 μ.

365.—Cladosporium herbarum Lk. var. torulosum B. & Br.

This variety was described by Berkeley and Broome in Fungi of Ceylon, No. 886, as "Floccis erectis torulosis; sporis dein uniseptatis. On leaves of *Anamirta*. Spores 0·0003-0·0005 long."

The fungus forms small black-brown patches on the under surface of the leaf. The conidiophores are dark-brown, up to 300 μ high, 4 μ diameter, slightly inflated at the base. In some instances they are inflated to 6 μ diameter just below a septum, but this is not universal. The conidia are oval, 5-10×3-7 μ, or subglobose, 4 μ diameter, or oblong-oval, one-septate, constricted or not, 12-16×5-6 μ, or cylindric, two-septate, 26×6 μ.

This inflation of the conidiophore is of common occurrence in species of *Dematiae*, and it is not feasible to make a variety on this character only.

366.—Helminthosporium gigasporum B. & Br.

Berkeley and Broome's description of this species, in Fungi of Ceylon, No. 882, is "Flocci simplices obtusi; sporis maximis, hic trun-

catis, illic attenuatis, apice hyalinis, multiseptatis (No. 246). On wood. Spores 0·0045 long."

The specimen, Thwaites 246, in Herb. Peradeniya, is on a dead stem. The conidiophores are erect, simple, rigid, up to 1 mm. high, 20 μ diameter below, attenuated to 12 μ above, black-brown, and arise singly, or fasciculate in small clusters, close together, forming a dense pile extending over several centimetres. In this specimen the available conidia are 100-130 μ long, narrow flask-shaped, or clavate with a long cylindric tip, 20 μ diameter below, 5 μ diameter above, attenuated in the upper third, 10-14-septate, very thick-walled; the tip may be straight or curved. In a specimen on tea from Pambagama (No. 5737, June, 1918), the conidia are up to 300 μ long, the basal clavate part about 60 μ long and the cylindrical tip, 240 μ long, 4-5 μ diameter; in this specimen the wall and septa are thinner than in the type.

367.—Helminthosporium atropurpureum B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 884, as "Effusum, atropurpureum, floccis erectis apice clavulato-divisis; sporis oblongis triseptatis. On smooth bark, Nov. 1867. Spores 0·001-0·0013 long."

The type specimen is in bad condition; it is apparently on some Malvaceous plant. The conidiophores are in clusters of about a dozen, simple, rigid, up to 200 μ high, 8 μ diameter below, slightly attenuated upwards, purple brown, septate. The conidia are cylindric, almost equal, dark brown, three-septate, not constricted, minutely warted, one end rounded, the other truncate, 20-28 × 5 μ.

368.—Helminthosporium Arecae B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 883, as "Pulvinulis mollibus e fibris radiantibus; sporis magnis obovatis 3-septatis (No. 164). Forming little patches on the leaves of *Areca Catechu*. Spores 0·002-0·0023 long. Sometimes the spores are more than triseptate, when they are much attenuated below."

The specimen in Herb. Peradeniya is marked "on leaves of palms." The fungus forms black superficial pulvinate stromata up to 0·6 mm. diameter, from which hyphae radiate over the surface of the leaf and form a network about 0·2 mm. wide. The base of the stroma is pseudo-parenchymatous. The repent hyphae are about 3 μ diameter, irregularly contorted, often united laterally into broad strands. The stroma is densely covered with erect, dark-brown, rigid, thick-walled conidiophores, up to 200 μ high, 6 μ diameter below, expanding to 12 μ dia-

meter above. The conidia are 46-56 μ long, very variable in shape; some are obclavate, 46×14 μ, others broadly flask-shaped, 48×20 μ, and others broadly oval with an attenuated apex. In the latter the basal part is 32-42×20-26 μ, and the attenuated apex, 16-20×4-6 μ. The spores are three to four septate, truncate at the base, often with the lowest cell but one darker than the others.

This appears to be closely similar to *Exosporium megalosporum* Penz. and Sacc., but the spore measurement given for the latter species is larger (100-150×15-16 μ). It may be known as *Exosporium Arecae* (B. & Br.).

369.—Helminthosporium calicioideum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 881, as "Caespitosum, congestum, fastigiatum; sporis sursum truncatis, deorsum attenuatis, multiseptatis (No. 151). On wood. Look at first like a *Calicium*. Spores 0·003-0·004 long."

The specimens are on a dead herbaceous stem. They are erumpent, with a short, stout glabrous stalk, up to 0·4 mm. diameter and 0·3 mm. high, which expands abruptly into a discoid head, up to 1 mm. diameter. The head is purple brown, and in the larger type specimens is now flattened, no doubt through pressure in drying, as the conidiophores are depressed. The stalk is embedded in the host tissue to a depth of 0·5 mm., the embedded part being of the same diameter as the external part. The whole length of the stalk is composed of fused longitudinal hyphae, which, in the embedded portion, are hyaline in thin sections. These hyphae separate above, and form a head of somewhat flexuose, purple, thick-walled conidiophores, 6 μ diameter.

The conidia vary in length from 56 to 108 μ, and in diameter from 12 to 16 μ. The shorter are clavate or fusoid or subcymbiform; the larger are clavate, with an attenuated apex up to 30 μ long, 4-8 μ diameter. They are pale fuscous or pale purple grey, thick-walled, 8 to 15 septate, straight, curved, or flexuose.

As this species forms synnemata, it should be referred to *Podosporium*, as *Podosporium calicioideum* (B. & Br.).

As in their description of *Helminthosporium Arecae*, Berkeley and Broome regarded the apex of the spore as the base.

370.—Isaria congregata B. & Br.

The original description of this species, in Fungi of Ceylon, No. 862, is "Congesta, clavaeformis, fusca, capitulis pallido-umbrinis; sporis elongatis, sursum obtusis, deorsum acuminatis (No. 140). On wood,

Nov., 1861. Densely crowded: flocci towards the upper joints with the articulations deeply indented; spores 0·0006 long. Possibly a state of some *Sphaeria*."

On the specimen in Herb. Peradeniya, the synnemata arise from the blackened wood or the bark in small clusters. They are connate at the base, sometimes springing from a small pulvinate stroma, purple brown, diverging, subcylindric, attenuated upwards, up to 2 mm. high, 60-100 μ diameter, composed of parallel hyphae which separate as conidiophores above, the stalk tomentose with diverging conidiophores here and there. The conidiophores are 3 μ diameter, branched above, each branch terminating in a cluster of phialides, like a *Penicillium*. The phialides are narrow flask-shaped, or subcylindric, 12-16 μ long, inflated at the apex. The hyphae of the stalk are red-brown by transmitted light, the free conidiophore pale fuscous or almost hyaline. The conidiophores and phialides are everywhere minutely verrucose. The conidia are oval, pale fuscous or almost hyaline, minutely warted, 3-6×2-2·5 μ. From the inflated apex of the phialide, it would appear that each bears several conidia. It is not possible to say whether they are in chains or not from the specimen, but it would appear probable that they are not.

On the old classification, this species should have been placed in *Graphium*, not in *Isaria*. The conidiophore, however, appears to be different from that of any described species. As suggested by Berkeley and Broome, it is probably the conidial stage of a pyrenomycete.

One piece of Thwaites 140 bears, in addition to *Isaria congregata*, a byssoid stroma composed of somewhat rigid, brown hyphae, 4 μ diameter, which branch dichotomously. This does not appear to be related to the *Isaria*.

371.—Oedemium sparsum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 903, as "Floccis subramosis hic illic processus hyalinos sporas fusiformes gerentes emittentibus (No. 431). On *Pandanus odoratissimus*. Sometimes divided at the apex in a radiating manner. Spores 0·001 long."

In Thwaites 431 in Herb. Peradeniya, the synnemata are scattered, black, rigid, subulate, inflated at the base to 100 μ diameter, 50 μ diameter above the inflation, attenuated to 24 μ at the apex. They are composed of parallel hyphae, a few of which diverge at different heights as simple, rigid, somewhat recurved, irregularly geniculate conidiophores, up to 64 μ long, 4 μ diameter, reddish-brown, hyaline at the apex. The apex of the synnema divides into a few similar conidiophores. The conidia are narrow-oval or subcylindric, rounded at one end, sub-

acute at the other, straight or slightly curved, 3 to 5 septate, slightly constricted at the septa, pale fuscous, 24-32 × 6-8 μ.

Very few attached conidia are now present. Numerous other *Dematiae* occur on the specimen, the most abundant conidium being spherical, black-brown, strongly verrucose, 10-12 μ diameter. The septate spore has, however, been found attached, and it is apparently the spore measured by Berkeley and Broome. The fungus is a *Podosporium*, and will stand as *Podosporium sparsum* (B. & Br.).

372.—Fusidium pulvinatum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 878, as "Candidum, pulvinatum, sporis cylindricis (No. 166). On dead stems of herbaceous plants. Spores 0·0004 long."

The fungus forms small, irregularly pulvinate, waxy looking masses, up to 0·3 mm. long and 0·2 mm. diameter, gregarious in small patches and united by narrow waxy bands, or by strands of mycelium. Examination shows that it is a *Clonostachys*, the conidiophores and conidia adherent in a continuous mass.

The conidiophores are short, about 80 μ high, branched in the upper 60 μ. The stem is stout, 4 μ diameter, and the branches thinner, 2 μ diameter. The ultimate branches, with their adherent conidia, are up to 30 μ long and 6-9 μ diameter. The conidia are hyaline, continuous, oblong with rounded ends, 4-6 × 2-3 μ.

This may be known as *Clonostachys pulvinata* (B. & Br.).

373.—Stilbum compressum B. & Br.

Berkeley and Broome described this species, in Fungi of Ceylon No. 867, as "Congestum, albidum, stipite compresso; sporis subellipticis (No. 742). On decaying fruit of *Citrus decumana*, crowded like the prickles of an *Irpex*; spores 0·0002 long."

The synnemata are gregarious, sometimes fasciculate and connate at the base, subtranslucent, up to 0·7 mm. high. The stalk is about 0·4 mm. high, laterally compressed, 0·2 mm. broad, clothed with loose longitudinal hyphae. The head is up to 0·4 mm. broad, 0·3 mm. high, sometimes lobed. The conidiophores bear whorls of phialides towards and at the apex, the phialides being narrow flask-shaped, 8-12 μ long, 1·5 μ diameter below. The conidia are hyaline, oval, or oblong-oval, ends rounded, 4-5 × 2-2·5 μ. Chains of conidia have not been observed, but it is most probable that the fungus is a *Coremium*. It may stand as *Coremium compressum* (B. & Br.).

Thwaites 742 also includes a hyphomycete which grows in minute white tufts.

374.—Aegerita mellea B. & Br.

The original description of this species, in Fungi of Ceylon, No. 909, is "Minuta, subglobosa, mellea (No. 1019). On lichens. Peradeniya, Dec., 1868. Small yellow tremelloid specks scarcely visible without a lens."

The sporodochia are now translucent amber, flattened pulvinate, up to 0·2 mm. long, 0·1 mm. broad, or subglobose, 0·15 mm. diameter. They are superficial, scattered or clustered. The conidiophores are irregular, about 5 μ diameter, and terminate in hyaline, smooth pseudoconidia, either broadly oval or globose, 10-16×7-12 μ The pseudoconidia may be in chains of two, or a pseudoconidium may bear a terminal cluster of two or three.

375.—Psilonia gilva Fr.

This species was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 914, from Thwaites 257.

The specimen in Herb. Peradeniya bears tawny brown, effused, minutely tomentose, thin patches, a few millimetres long and broad, which become blackish brown when old. The older patches are readily separable from the substratum. The basal hyphae, in the younger stromata, are hyaline, up to 4 μ diameter, and give off branches, some with clavate or lobed spinulose tips up to 4 μ diameter, others curved, slender, 1 μ diameter, which intertwine and form the context of the stroma. In the older stromata the hyphae are yellow-brown, chiefly longitudinal, running parallel to one another over the bark, 4 μ diameter at the septa, often inflated to 6 μ in the middle of a segment. These hyphae bear sessile, oval, yellow-brown, spinulose conidia, about 4×3 μ, laterally.

This is probably an immature example of a basidiomycete. It is certainly not *Volutella gilva* (Pers.) Sacc.

376.—Hymenopsis atrocarneum (B. & Br.) Sacc.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 1207, as *Myrothecium atrocarneum*, "Disco atro, deplanato, e massa carnea oriundo; sporis ellipticis (No. 167). Spores 0·003 long." It was transferred to *Hymenopsis* in Saccardo, Sylloge Fungorum, IV, p. 747.

The sporodochia are erumpent, at first almost plane, becoming convex, irregularly circular or oval, up to 1 mm. diameter, attached

over about half the base, without differentiated margin. In the herbarium specimens they are orange, sub-translucent, becoming black from the centre outwards. Only the mass of conidia becomes black. The conidiophores form a dense palisade layer, and are about 24 μ high, the lower half being simple, cylindric, 2 μ diameter, and bearing at its apex about four narrow flask-shaped phialides, 1·5 μ diameter. The conidia are oblong-oval, pale fuscous, 5-7 × 2·5-3 μ; they remain adherent in chains.

377.—Myrothecium Carmichaelianum Grev.

This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 872, from Thwaites 1049. According to Saccardo, the name should have been *Myrothecium Carmichaelii* Grev., which is *Myrothecium roridum* Tode.

The sporodochia are thin, flat, adnate, black, either circular, about 0·4 mm. diameter, or forming irregular patches, up to 1·5 × 1 mm., without differentiated margin. The herbarium specimens have white floccose patches on the sporodochia, but these are an adventitious hyphomycete. The conidiophores are simple, subcylindric, attenuated upwards, about 12 μ long, 2 μ diameter. The conidia are green in mass by transmitted light, greenish fuscous individually, narrow oval, one end acute, the other slightly constricted and papillaeform, 6-8 × 2-3 μ.

This species is a *Hymenopsis*. Its conidia differ from those of *Myrothecium roridum*, and it has no white margin. It may be known as *Hymenopsis tenuis* n. sp.

378.—Anthina cinnabarina B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 873, as "Compressa, parce ramosa, sursum sporis minutissimis albis tecta (No. 41). Amongst fragments of plants. Sometimes forked: a few slender threads accompany it, which are perhaps imperfectly developed conidiophora. Spores globose, too minute to measure."

The specimens of Thwaites 41 in Herb. Peradeniya are on fragments of a cocoon, and the fungus is most probably the *Isaria* of *Cordyceps coccinea* Penz. and Sacc.

379.—Stilbum clavula B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 870, as "Clavatum, intus cellulosum, e materie nigra oriundum, sursum cinereum, deorsum, nigrum; sporis oblongis obtusis (No. 150). On bark, etc. Nov., 1867. Spores 0·0005 long."

In Fungi of Ceylon, No. 869, Berkeley and Broome recorded *Stilbum byssigena* B. & Br., for Ceylon, the name being a substitution for *Stilbum byssisedum* B. & C., described from Cuba. The Ceylon specimen was Thwaites 123, and its spores were said to be fusiform, 0·0005-0·0006 long by 0·0002.

The two Ceylon specimens, Thwaites 123 and 150, are the same species, 150 being a young stage. The young specimens in Thwaites 123 exactly match Thwaites 150.

The young specimens are up to 1·2 mm. high, slightly expanded at the base, 0·1 mm. diameter below, clavate, expanding uniformly upwards into an ovoid head 0·3 mm. diameter, dark-brown, pruinose.

They are white internally, with a brown outer layer, soft, not carbonaceous. They are composed of longitudinal hyphae, some of which are up to 7 μ diameter and have contents which stain brownish yellow with iodine. The head bears a palisade layer of cylindric or clavate conidiophores, 16 μ high, 4 μ diameter. The conidia are narrow oval, oblong-oval, or fusoid, one or both ends acute, 9-12×2·5-4 μ, hyaline.

The larger specimens have a stalk up to 0·3 mm. diameter, purple-brown, minutely tomentose, irregularly fluted, expanding abruptly into a subglobose, brown, tomentose head, up to 1 mm. diameter. These specimens show a peripheral layer of developing perithecia.

The wood may be covered by a thin byssoid layer, or may be merely blackened.

These are developing clavae of some Xylariaceae. The Cuban fungus, which is the type of *Stilbum byssigenum* B. & Br., has not been examined.

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The Fungi associated with disease in Vanilla

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WITH TWO PLATES

The first record of a disease of Vanilla (*Vanilla planifolia* Andr.) was made by Cooke in 1886. He had received specimens from Antioquia, Colombia (South America), and on these he found two fungi which he described as *Uredo scabies* and *Gloeosporium Vanillae* respectively. Cooke ascribed the disease to the *Uredo*, which he stated appeared to be very destructive and was regarded as a pest by the cultivators. The habit of the *Uredo* was said to be peculiar and characteristic, giving the leaves a scabby appearance, and in the description of the fungus it was stated that the spots which it caused were bullate, and surrounded by a black line. This effect of the *Uredo* on the leaf differs from that of the other fungi recorded on Vanilla. As a rule, the internal tissue decays and shrinks, leaving the epidermis or the cuticle as a thin grey persistent membrane, often free from the underlying decayed tissue.

In 1891, Massee published an account of his investigations of a disease of Vanilla which occurred in the Seychelles, Mauritius, and Réunion. No field notes on the disease of that date are available, except that the pods turned black at either end or in the centre, and dropped off in the course of a day or two. Massee mentions that some of the living leaves when received at Kew bore minute, dull red or amber pustules on slightly discoloured patches. He found, or developed on his specimens, three fungi, a *Hainesia*, a *Cytospora*, and a *Calospora*, which he regarded as stages of the same species, *Calospora Vanillae* Massee.

Massee also stated that these three fungi were present on Cooke's specimens from Antioquia (Antigua in error, in Kew Bulletin, 1892, p. 120), and that *Gloeosporium Vanillae* Cke. was identical with the form he assigned to *Hainesia*. Cooke, however, gave the spores of *Gloeosporium Vanillae* as 18–25 × 5–6 μ, while Massee described the spores of his *Hainesia* as "constant in form and size, measuring 9–10 × 3·5–4 μ".

Massee recorded that all the stages of the disease had been followed at Kew, on cultivated orchids belonging to the genera *Oncidium* and *Dendrobium*.

In 1895, Hennings received a diseased Vanilla pod from the Cameroons, and after summarising Massee's account of the Vanilla disease of the Seychelles, stated that the Cameroon specimen was apparently attacked by the same fungus. He also recorded the receipt of diseased Vanilla leaves from Mexico, on which he found a Stictidcae, *Ocellaria Vanillae*, and a *Gloeosporium* which he considered different from *Gloeosporium Vanillae* and named *Gloeosporium Bussei*. The *Ocellaria* was said to be very injurious, and the *Gloeosporium* most probably as destructive as *Gloeosporium Vanillae*.

Hennings further recorded that *Gloeosporium affine* Sacc. often attacked the leaves of Vanilla plants in the green-houses of the Berlin Botanic Gardens, causing black spots which ultimately spread over the whole leaf and killed it.

Miss Stoneman, in 1898, published a description of *Gnomoniopsis Vanillae*. This had been found on leaves of a cultivated species of *Vanilla* in North America, presumably a green-house plant. Its conidial stage was a *Colletotrichum*.

In 1902, Delacroix summarised the information then existing concerning the species of *Gloeosporium*, etc., on Vanilla, and added further observations of his own. Nine years previously, he had received specimens of diseased Vanilla from Réunion, and had found on them a fungus which he described as *Vermicularia Vanillae*. In 1900, he received further specimens from Grand Comoro and from Madagascar, and in 1901 from Tahiti; and after a study of these he arrived at the following conclusions:—

Gloeosporium Vanillae Cke. may be either *Gloeosporium* or *Colletotrichum*. In some cases it forms a pycnidium, which may be correspondingly either a *Phoma* or a *Vermicularia*. It was the latter which was described as *Vermicularia Vanillae*, while the former constituted Massee's *Cytospora*, which, from the description and figure, was evidently not a *Cytospora*. *Gnomoniopsis Vanillae* Stonem. was immature *Calospora Vanillae*.

It is to be noted that Delacroix found *Calospora Vanillae* on his specimens. He stated that it was not so deeply immersed as shown by Massee, and that the ostiolum was only feebly coloured. He did not carry out infection experiments with the ascospores, because no Vanilla was available for infection at the time when the ascospores were mature.

Saccardo, in Sylloge Fungorum, III, p. 709, had enumerated *Gloeosporium affine* Sacc., as occurring on *Hoya* and Vanilla at Padua, and on leaves of orchids at Dresden. Delacroix obtained examples of the Dresden fungus and of that on Vanilla, parts of Saccardo's specimens, and found that these were different species, the Vanilla specimen being identical with *Gloeosporium Vanillae*. Hence Delacroix concluded that *Gloeosporium affine* Sacc., in so far as it related to the species on Vanilla, was identical with *Gloeosporium Vanillae* Cke.

In the same paper, Delacroix described a *Uromyces*, on Vanilla from Tahiti, as *Uromyces Joffrini*. This occurred on the same pods as *Gloeosporium Vanillae*.

Zimmermann, also in 1902, published a paper on some diseases of Vanilla in Java, one of which was apparently the common Anthracnose or Soft Rot. It attacked the stems, and more rarely the leaves. The stems became pale brown and then dark brown to black, while the tissues ultimately shrivelled and dried up. On the old diseased stems yellowish-white acervuli appeared, which Zimmermann considered to be a *Colletotrichum*, and these were followed by a *Nectria*, *Nectria Vanillae* Zimm. Zimmermann apparently regarded these as stages of the same fungus, and the cause of the disease. Among other fungi described in the same paper were *Nectria peristomata* Zimm. and *Physalospora Vanillae* Zimm., the latter on decaying leaves.

In the same year, Hennings described from Java, *Nectria vanillicola* and *Phyllosticta Vanillae*. According to von Höhnel and Weese, *Nectria Vanillae* and *Nectria vanillicola* are forms of *Nectria tjibodensis* Penz. and Sacc.

In 1903, Hennings received diseased fruits of Vanilla from East Africa (Dar-es-Salam), and described another fungus, *Trullula Vanillae*, as the cause of the disease.

Scalia, in 1903, published a description of *Colletotrichum Vanillae* Scalia, which was found on leaves of Vanilla in the Botanic Garden at Catania, Sicily.

In 1907, Bernard examined diseased plants of Vanilla in Java and found on them a *Nectria*, which he described as *Nectria bogoriensis*. The specimens were old, and he was unable to decide whether the *Nectria* was the probable cause of the disease. Von Höhnel and Weese state

that *Nectria bogoriensis* Bern. is a form of *Nectria Bolbophylli* P. Henn. In that case, it is *Nectria haematococca* B. & Br., one of the commonest saprophytic Nectrias of the eastern tropics.

It may be noted that in some instances the fungi mentioned above have been recorded as occurring on *Vanilla odorata*. That is doubtless a mistake for *Vanilla planifolia*, the species usually cultivated as Vanilla (excluding Vanillons). All that is known of *Vanilla odorata* Presl is the original description.

In 1912, Maublanc published a summary of the different accounts of the fungi which had been described on Vanilla. This is practically the same, as regards its conclusions, as that of Delacroix ten years previously. Maublanc stated that *Gloeosporium Vanillae* Cke. develops setae and is then probably identical with *Colletotrichum Vanillae* Scalia. Moreover, instead of the open or flat fructification of the typical *Melanconiaceae*, the fungus may produce true pycnidia, either scattered or in groups. In that case, if setae are developed, it appears to be a *Vermicularia*, while if setae are absent it is a *Macrophoma*. When the *Macrophoma* pycnidia are grouped, the fructification resembles *Dothiorella*, and it was certainly this form, according to Maublanc, which Massee referred to *Cytospora*. Maublanc also suggests that the fungus which Zimmermann regarded as a *Colletotrichum* belonged to the *Tubercullariaceae*.

Shear and Wood, in 1913, in their investigation of the genus *Glomerella*, obtained diseased leaves of Vanilla from Florida. These bore acervuli in which setae were present in some cases but not in others. Plates were poured, using conidia from these acervuli. "Acervuli soon developed on the poured plates and four subcultures were made in tubes. Acervuli soon developed in the tubes but their number, size. and distribution varied greatly. In one tube there was only one large acervulus, in another the surface of the medium was thickly dotted with acervuli with pinkish spore masses. In some of the tubes the mycelium remained whitish, in others it became quite dark-coloured. The variations in amount and colour of the mycelium, and in the number, size, and distribution of the acervuli were very striking. No perithecia or perithecium-like bodies were found in any of these cultures. The conidia from the leaves ranged from 13·5 to 24 by 4·5 to 6 μ. There are no sufficient morphological characters to distinguish this fungus from that found on the grape and apple, *Gloeosporium rufomaculans* (Berk.) Thuem. It has, therefore, been referred to the same species. *Physalospora Vanillae* A. Zimm. is apparently the perithecial form." Setae were not found in culture.

In 1916, Meinecke published a report on Vanilla in Tahiti and Moorea. The principal disease, "La *Maladie* tout court des planteurs" was said to be Anthracnose, but the report does not add anything to our knowledge of the fungi or of the field characters of the disease.

VANILLA DISEASE IN CEYLON

The common Vanilla disease in Ceylon begins with the south-west monsoon rains about the middle of May and continues until about the end of August. August and September have usually a low rainfall. It becomes common again about the middle of October, when the north-east monsoon rains begin, and is checked by the dry weather in January.

The first sign of the disease is a yellowing of parts of the stem or the leaves. On the stem this usually begins either at the base of the stem, which is not necessarily in contact with the ground, or at a node; on the leaf it may originate at the tip or in the middle of the leaf. If the weather conditions become unfavourable for the development of the disease, it remains in this stage, sometimes for several weeks, until a wetter period sets in. The yellow areas then turn chocolate brown, and in a week or ten days become covered with pink masses.

The leaf is attacked from the base, only when the disease passes from the stem to the leaf. On the other hand, in almost all the cases noted, the disease, when it begins on a leaf, does not travel from the leaf to the stem. Consequently it is quite common to see healthy stems with diseased dry leaves hanging on them. From these facts, there would seem to be a possibility that two fungi may be concerned in these effects.

The decayed leaves generally remain entire and attached to the stem, and dry up when the rains cease. They are then grey, the strong epidermis being longitudinally wrinkled owing to the shrinkage of the internal tissue. Decayed stems, on the other hand, are usually converted into a bundle of loose fibres.

The disease is a typical soft rot, though, owing to the thick epidermis of the plant, that may not be apparent from dried specimens. It is evident from the descriptions that the common disease of Vanilla in every Vanilla-growing country exhibits similar symptoms.

Four fungi have been found to occur regularly on Vanilla attacked by soft rot in Ceylon. These have been studied in pure culture from single spores and are described below. The practical work has been carried out by the junior author.

Species A.

This species was first observed in the perithecial stage on Vanilla attacked by soft rot which had been washed with 0·1 per cent mercuric chloride and kept in a glass dish. Cultures started with ascospores yielded the conidial stage. Subsequently both stages were identified on Vanilla soft rot specimens kept in glass dishes, and on diseased specimens in the field. In the latter case the fungus was found only on the stems.

The perithecia (Plate III, figs. 1, 2) are usually clustered, globoso-conoid or flask-shaped, 280–350 μ high, 245–280 μ diameter. In the flask-shaped examples, the neck may be up to 245 μ long and 40 μ diameter, expanded at the apex. The perithecia arise from an erumpent parenchymatous stroma, sometimes singly, but more usually in small groups. In cultures on sterilised Vanilla stem, the base of the perithecium may be embedded in the stroma, or the perithecium may be simply seated on the stroma. In cultures on maize-meal agar, the perithecia (Plate III, fig. 3) are more deeply embedded in the stroma, so that they appear rather as loculi in a common stroma, with conoid ostiola. The wall of the perithecium is thick and parenchymatous. The perithecia are black, opaque, paler at the apex, rather strongly tomentose in some cultures, but only slightly so on Vanilla stems. The asci (Plate IV, fig. 3) are clavate, eight-spored, spores biseriate, 117–140 × 12–17 μ, the sporiferous part usually about 105 μ long. Long slender paraphyses are present. The ascospores are hyaline, continuous, allantoid, 25–35 × 8–11 μ. In culture the perithecial wall sometimes develops a cluster of setae. Parenchymatous bodies, resembling perithecia (Plate I, fig. 4), are produced in the agar.

The acervuli are subepidermal, becoming erumpent, circular, 230–280 μ diameter, or oval, 210 × 245 μ. The mass of spores is white or pallid, becoming pale pink and finally rose-purple. The conidia (Plate II, fig. 2) are greenish hyaline, cylindric, straight or slightly curved, 22–35 × 7–11 μ. The conidiophores (Plate IV, fig. 1) are septate, branched below, the branches terminating either in setae or in 1–2-septate basidia, 35–70 × 6–8 μ, at first hyaline, becoming brown. The setae are dark brown, straight, septate, subacute, slightly bulbous at the base, 105–235 μ high, 3–5 μ diameter below. The acervuli may appear black at first, or on dried specimens, because of the setae.

On maize-meal agar, the fungus forms a thin mycelial growth within the medium and the surface becomes dotted with greenish black bodies within five days. Some of these bodies are acervuli, others stromata. In a week, the surface is entirely greenish black. In about

a month, perithecia are produced in groups on the stromata. The agar is not coloured. Cultures from ascospores or conidia produce both stages in abundance. Cultures carried on by transfer of mycelium become sterile, though perithecia are produced up to the fifth generation.

There is little doubt that this species is *Gnomoniopsis Vanillae* Stoneman, though the latter was described as lacking a stroma, and having asci, 75–80 μ long ; its conidial stage was said to be a *Colletotrichum*, with crowded, septate basidia, 30–45 μ long. The dimensions of the conidia of the *Colletotrichum* are not given in Saccardo

It would also appear probable that this species provided Massee's *Calospora Vanillae*. The latter was said to be globose, with a prominent conico-cylindric curved ostiolum. The perithecia were immersed, with the ostiolum projecting, but Delacroix stated that the perithecia observed by him were not so deeply immersed as figured by Massee. The fungus had long, linear paraphyses, and its ascospores were subcylindric with rounded ends, slightly curved. But Massee described the spores a striseptate, and 15–16 × 5 μ, both of which details are at variance with the Ceylon species. Unfortunately, there does not appear to be any type specimen of *Calospora Vanillae* in existence. Miss Wakefield informs us that there is no type in Herb. Kew, and, from enquiries she has kindly made, it appears that there is none at the New York Botanic Garden. Consequently it is not possible to verify Massee's description.

The conidial stage would appear to be undoubtedly *Vermicularia Vanillae* Delacr. Delacroix withdrew his species as identical with *Gloeosporium Vanillae* Cke., but he described its spores as 27 × 11 μ, while Cooke's measurement of the spores of *Gloeosporium Vanillae* was 18–25 × 5–6 μ. As several fungi may occur together on diseased Vanilla, it is probable that the species examined by Delacroix on his revision of his fungus was not the same as that examined on the first occasion. Delacroix's figure strongly suggests the present species, but it is a *Volutella*, not a *Vermicularia*.

Species B.

The perithecial stage of this species is commonly obtained when specimens of Vanilla attacked by soft rot are kept in a glass dish, but it has not been observed in the field.

The perithecia are erumpent, becoming almost superficial, scattered or clustered, black, pale at the apex, subconoid, up to 200 μ diameter and 175 μ high. The wall is parenchymatous. The asci (Plate IV, fig. 6) are lanceolate or clavate, with obliquely biseriate spores, 54 × 12 μ, without paraphyses. The ascospores are fusoid or subcymbi-

form, curved, continuous, hyaline, ends subacute, 14–20 × 5–6 μ. In culture on maize-meal, some of the perithecia have a pale conical beak up to 70 μ high ; one perithecium, the body of which was 120 μ high and 85 μ diameter had a cylindrical beak 105 μ high and 40 μ diameter. The majority of the perithecia, however, are more or less conoid. A few hyphae may arise from the wall of the perithecium in culture.

The acervuli are circular or oval, up to 0·4 × 0·2 mm., dull pink or salmon pink. The basidia are hyaline, continuous, 25–50 × 3–4 μ. The conidia (Plate IV, fig. 9) are hyaline. continuous, cylindric, rounded at both ends or pointed at one end, 12–20 × 3–6 μ, the average of one hundred being 15 × 5 μ. Some acervuli lack setae, others contain olive brown, septate, obtuse, somewhat irregular setae, 55–105 × 4–5 μ, usually comparatively few in number. On the fresh diseased leaves, the epidermis overlying an acervulus may split and open widely, exposing the mass of spores, or the spores may be extruded in a tendril through a small aperture.

In cultures from ascospores on maize-meal agar the fungus develops a white, loose, superficial mycelium. On this mycelium minute black masses are produced which may develop into either acervuli or perithecia. In old cultures, perithecia may occur in continuous groups (Plate III, fig. 5) for a length of an inch. The agar is not coloured. Both perithecia and acervuli are produced abundantly in repeated subcultures on maize-meal agar, whether by transfer of ascospores, conidia, or mycelium. Setae were not found in cultures on maize-meal agar, and they occurred only rarely in cultures on sterilised Vanilla leaves.

The perithecial stage of this species is evidently *Physalospora Vanillae* Zimm. Zimmermann described the perithecia of his species as immersed at first, then erumpent, with a stout conical ostiolum, paler than the remainder of the perithecium, and with ascospores, tereto-fusoid, curved, somewhat obtuse, 24–28 × 5–6 μ. The latter measurement is greater than in Ceylon specimens. Shear and Wood refer *Physalospora Vanillae* Zimm. to *Glomerella cingulata*, but it is doubtful whether they had this species.

This appears to be the commonest species on Vanilla attacked by soft rot in Ceylon. Hence it would be expected that its conidial stage would be the one most frequently described by those who have examined similarly diseased specimens of Vanilla fror other countries. But there is considerable doubt on this point, and it is preferable to postpone the discussion of these conidial forms until other species have been enumerated.

Species C.

This was first observed on definite spots on Vanilla leaves. The spots were large, oval, up to 7 cm. long and 2 cm. broad, greyish brown with a dark brown margin, the grey-brown part splitting out. The acervuli were situated chiefly near the margin of the spot or patch, and were black, oval, up to 0·5 × 0·25 mm., or circular, 0·25 mm. diameter, covered by the epidermis. The conidia were oblong-oval or elliptical, 12–16 × 4–6 μ, on short basidia. Branching hyphae with terminal conidia occurred in old acervuli. Setae were not found.

Subsequently this species was found on leaves and stems attacked by soft rot, *i.e.* without definite spots, and was taken into culture.

In cultures on maize-meal agar, a thin, hyaline layer of mycelium developed over the surface, on which, within a week, there appeared small black stromata which produced pink masses of spores. These stromata usually occurred in zones. When old, the conidia in the acervuli germinated and formed flattened pulvinate loose masses of hyphae. Setae occurred rarely. The agar was not coloured. On sterilised Vanilla leaves the growth was similar, but no setae were found. Perithecia were not formed in culture, but globose parenchymatous bodies, with a thick brown cortex, and hyaline and partly hollow within, occurred in the medium in maize-meal agar cultures.

The spores, in culture, were hyaline, continuous, usually oblong-oval but sometimes cylindric, 12–18 × 5–6 μ. (Plate IV, figs. 10–12). The basidia were hyaline, septate, irregularly constricted, 15–25 × 5–6 μ. The basal layer of the acervulus, in culture, is more compact and darker in colour (olive brown) than in the acervuli of species B or D. The setae are black, acute, 80–105 × 2–3 μ; they occur rarely and late. Dark, olive brown hyphae grow out from the base of the acervulus.

This species differs from the *Gloeosporium-Colletotrichum* stage of species B in its irregular septate basidia, and in the shape of its spores.

Species D.

This species occurs on brown sodden leaves and stems, and is usually the commonest form on old diseased leaves which have withered and dried. The acervuli are pink, 140–175 μ long and 95–105 μ broad, the basal stroma being pale olive brown,. The basidia are hyaline, not septate, regular, rounded or acute above, 20–45 × 2–3 μ, sometimes 5 μ diameter. The conidia are ovate, or narrow-oval, rounded at one end and subacute at the other, hyaline, continuous, 12–25 × 3–7 μ. (Plate IV, figs. 13, 14) The setae are olive brown, sub-hyaline above, two to four septate, sometimes flexuose, 70–135 × 4–5 μ.

In cultures on maize-meal agar, a thin, superficial filmdeveloped, which produced conidia in abundance on the hyphae. Subsequently a white floccose mycelium was produced. Black stromata occurred at the edge of the slant. After about eighteen days, pink masses of spores appeared in large numbers all over the surface of the medium, and in some cases on the black stromata. The pink pustules were found to be a *Gloeosporium* stage at first, but developed setae later. When old, the white floccose mycelium became dull grey. Parenchymatous bodies were formed in the agar, similar to those in cultures of species C. Perithecia were not produced.

The agar became reddish pink, then brownish orange, then purplish brown, and finally tawny olive (Ridgway).

This species differs from C in its basidia and spores, as well as in its regular production of setae. The basal stroma of the acervulus is not well defined in cultures.

SYSTEMATIC

There are thus four species which usually occur in Ceylon on Vanilla leaves and stems attacked by Soft Rot. One of these forms acervuli which are white or pallid at first and so are readily distinguished. The other three form pink acervuli on the fresh moist specimens. On old dried withered leaves, from which the spore masses have to a great extent disappeared, all the acervuli may appear black.

The four species are :—

A. A *Botryosphaeria*, with a *Volutella* imperfect stage, the conidiophores of the *Volutella* being branched, the basidia septate, and the conidia cylindric, straight or slightly curved 22–35 × 7–11 μ. The densely fasciculate base is a marked feature of this imperfect stage.

B. A *Glomerella*, with a *Gloeosporium-Colletotrichum* imperfect stage, which produces few setae ; the basidia of this imperfect stage are hyaline, continuous, 25–50 × 3–4 μ, and the conidia, cylindric, sometimes acute at one end, 12–20 × 3–6 μ.

C. A *Gloeosporium-Colletotrichum* which produces setae in culture only and then sparingly; its basidia are irregular, septate, short, 15–25 × 5–6 μ, and the conidia *oblong-oval to cylindric*, 12–18 × 5–6 μ. It has a dark, compact, basal stroma in culture.

D. A *Gloeosporium-Colletotrichum* which produces setae regularly; its basidia are continuous, regular 20–45 × 2–5 μ, and its conidia *ovate, or narrow-oval*, 12–25 × 3–7 μ.

The morphological differences between B, C, and D, exclude the supposition that C and D are non-ascigerous strains of B.

A is *Gnomoniopsis Vanillae* Stonem. and perhaps the basis of *Calospora Vanillae* Mass. It may be known as *Botryosphaeria Vanillae* (Stoneman). Its *Volutella* stage is *Vermicularia Vanillae* Delacr., and will stand as *Volutella Vanillae* (Delacr.).

B is *Physalospora Vanillae* Zimm., and will stand as *Glomerella Vanillae* (Zimm.).

For C and D, and the imperfect stage of B, there are a number of possible names, but without an examination of the type specimens, one can only make suggestions. Even with the aid of the types, it is doubtful whether any definite conclusions can be reached, as all these imperfect stages may occur on the same specimen. For the same reason, it is probable that some of the descriptions relate to more than one species.

Trullula Vanillae P. Henn. was said to have densely fasciculate, oblong-fusoid or clavate, slightly fuscous basidia, 10–14 × 4 μ, and oblongo-cylindric or clavate conidia. The dimensions of the conidia were not stated, and consequently it is impossible to make any use of this description. It would seem possible that the measurements given for the basidia were intended for the conidia.

Colletotrichum Vanillae Scalia was described as having very black acervuli, almost resembling a *Vermicularia* at first, erumpent and sub-columnar, with fasciculate, cylindric, one-septate basidia, 24–34 × 6·5—7 μ; conidia oblongo-cylindric, frequently inequilateral and almost curved, 18–21 × 5·5—7 μ; setae sub-tuberculate at the base, sub-rigid or flexuose. This appears, from the description, to be nearest to the *Volutella* stage of species A; it differs in having its setae sometimes thickened at the septa, and the conidia smaller.

Gloeosporium Vanillae Cooke was said to have acervuli covered by the blackened epidermis, and conidia, 18–25 × 5–6 μ, elongato-ellipsoid, straight, with rounded ends. This would appear, from the description, to answer best to species C, which has notably black acervuli, (though the colour is not due to blackened epidermis), and oblong-oval to cylindric spores. But the spore measurements given by Cooke are larger than those found for that species in Ceylon. Cooke's spore measurements are nearer those of species D, but the shape of the spores of the latter is different, and it produces setae regularly in nature. If this identification is correct, *Gloeosporium Vanillae* Cke. is not related to *Glomerella Vanillae* (Zimm.).

Gloeosporium Bussei Henn., with oblong-cylindric conidia, 11–15 × 4·5—5·5 μ, generally curved, and basidia 30 μ long, 3–4 μ diam., appears, from the description, to be referable to the *Gloeosporium-Colletotrichum* stage of *Glomerella Vanillae* (Zimm.).

Shear and Wood did not obtain perithecia in their cultures of the fungus from Vanilla on maize-meal agar. Their account suggests that they were dealing with two species, but the absence of perithecia or perithecium-like bodies in culture would appear to exclude all the four species under discussion. They did not describe the basidia or the shape of the spores, and the details given are insufficient for comparison.

The material examined by Massee was sent from the Seychelles in layers of blotting paper, and, *fide* Massee, it reached him in good condition. It is probable, however, that, under those conditions, the acervuli on the drying specimens would not open widely, and that may account for Massee's description of the masses of conidia as extremely minute, or extruded in tendrils. His *Hainesia* would appear to be undoubtedly a *Gloeosporium*; its basidia were simple or branched, not septate, up to 25 × 3 μ, and the conidia, 9–10 × 3·5—4 μ. This spore measurement is too large for *Phyllosticta Vanillae*, but smaller than that of the Gloeosporiums found on Vanilla in Ceylon. There is, however, a possibility that this form may have developed in transit and have produced spores smaller than usual. His measurement of the acervulus, "only just visible to the naked eye, rarely reaching 5 mm. in diameter" is probably an error for 0·5 mm. The conidia were said to be elliptic–oblong; the figure shows them slightly more elliptic than the usual *Gloeosporium* spore, with the ratios of length to breadth 6 to 2 or 5 to 1·5.

Massee's *Cytospora*, from his figure, is certainly not a *Cytospora*. It would appear to be merely a cluster of acervuli of a *Gloeosporium* which have not opened widely. The spores were said to be elliptic-oblong, 14–16 × 6–7 μ; the figure shows the ratio of length to breadth, 7 to 2·5. Massee did not observe setae.

In describing the formation of the pycnidia of the *Cytospora* Massee referred to a stroma, but it is not clear whether he meant more than the tissue of the supposed pycnidium; his figure does not show a stroma. Similarly, he stated that *Calospora Vanillae* developed on the old stromata of the *Cytospora*, but his figure of that species does not show a common stroma. Parts of his description might be read as indicating that *Calospora Vanillae* developed on a parenchymatous stroma, but that interpretation is doubtful.

As far as any conclusion is possible, it would appear probable that Massee's *Hainesia* and *Cytospora* were both the same *Gloeosporium*, and the same as the Ceylon *Gloeosporium* species C. In that case, they would be referable to *Gloeosporium Vanillae* Cke. *Calospora Vanillae* would appear to be based on the Ceylon species A, but the spores of the latter are larger and not septate.

INFECTION EXPERIMENTS

Infection experiments were carried out, with conidia from sub-cultures of the single spore cultures, on detached leaves and pieces of stem in sterilised glass dishes and on living vines. The material in all cases was washed with corrosive sublimate solution (1 in 1000) and rinsed thoroughly afterwards with distilled water. In the case of living plants, a gas jar was inverted over the upper part of the plant, on which the inoculations were made, damp cotton wool being placed inside and the mouth plugged with cotton wool. Checks were kept in all cases.

In the case of species A, 12 inoculations on detached leaves, 6 of which were on wounded areas, proved failures; the conidia germinated on the wounded areas and produced appressoria but nothing further ensued. Three inoculations on pieces of stem, after wounding, were successful, both conidia and perithecia being produced. On living plants, 8 inoculations in the axil of the leaf, 5 unwounded and 3 wounded, were unsuccessful; and 6 inoculations on wounded leaves were unsuccessful with one possible exception. In the last case, the leaf was gathered and placed in a glass dish, where it developed the conidial stage only.

Four wounded detached leaves inoculated with conidia of species B did not develop any disease, but 2 wounded stem cuttings similarly inoculated both produced acervuli and perithecia. Inoculations on living plants with this species were unsuccessful. These included 6 wounded and 12 unwounded in the leaf axil, 2 on the wounded stem, and 9 on wounded and 19 on unwounded leaves.

In the case of species C, no infection was obtained. Inoculations were made on detached leaves, 2 wounded and 2 unwounded; and on living plants, 6 on wounded and 4 on unwounded leaves.

With species D, 5 inoculations on unwounded detached leaves were unsuccessful, and only one succeeded out of 5 on wounded leaves. On 3 wounded stem cuttings, infection was obtained in each case. On living plants, 6 inoculations on leaves and 6 in the leaf axil, in each series 3 on wounded and 3 on unwounded areas, were unsuccessful; while of 15 inoculations on the leaf, 10 after wounding and 5 without wounding, only two of the latter were successful and that after several months. In this last instance, the plants were inoculated on December 15th, 1922, and the glass jars removed on December 23rd; the plants were then exposed to natural conditions, and the two leaves showed symptoms of the disease on March 18th, after four days heavy rain.

Omitting the doubtful instances in the case of species A and D, it is seen that of 29 inoculations with species A, only 3 were successful, namely those on wounded stem cuttings; with species B, only 2 of 54 inoculations were successful, these being again on wounded stem cuttings;

14 inoculations with species C were unsuccessful; of 40 inoculations with species D, 4 were successful, one on a wounded detached leaf and three on wounded stem cuttings.

It will be evident that the results of these experiments are too fragmentary to be of any use. No explanation can be offered of this failure to reproduce by inoculation a disease which is at times very virulent. In the present experiments the material was held in a saturated atmosphere in all cases, and the range of temperature included that of the period when the disease occurs naturally on Vanilla. This failure, however, is not extraordinary, with species of *Gloeosporium* and *Colletotrichum*.

It is noteworthy that in the case of the two leaf infections with species D on living plants, which are believed to be delayed infections, the disease made its appearance after four days' rain in the normally dry, hot weather. This is parallel to the behaviour of *Colletotrichum Camelliae* on tea, serious outbreaks of which frequently follow a few days of rain in the hot season.

The experiments unfortunately do not show which fungus is to be regarded as the cause of Soft Rot of Vanilla or whether any of the fungi under experiment exhibit a preference for the leaf or the stem. Of nine successful inoculations, eight were on pieces of stem.

OTHER FUNGI ON VANILLA

Hennings described *Phyllosticta Vanillae* from Java as "maculis effusis, pallidis; pycnidiis sublenticularibus, membranaceo-atris, pertusis, 50–60 μ; sporulis oblongis, subfusoideis, continuis, 4–5 × 1·5—2 μ, hyalinis." A *Phyllosticta* has been observed on *Vanilla* leaves in Ceylon, which is probably referable to this species. It occurred on dry diseased leaves in company with *Colletotrichum* species D.

Cavara, in 1895, described *Laestadia Traversi* on *Vanilla* leaves in Italy. The description, as given in Saccardo, is, "Peritheciis dense gregariis sub epidermide nidulantibus dein erumpentibus, patellaribus, ostiolo prominulo, cirro albo praedito; ascis cylindracco-clavatis, 50 × 10–12 μ; sporidiis ellipticis hyalinis monostichis, 10 × 4 μ; paraphysibus nullis."

In Ceylon, a *Mycosphaerella* has been found on dry diseased leaves, in company with *Colletotrichum* species D. The perithecia are gregarious, on livid spots, black, slightly prominent, sub-epidermal, becoming erumpent, not beaked, 80 μ diameter. The asci are clavate, thick-walled, 32–36 × 7–8 μ. Paraphyses are absent. The ascospores are fusoid, hyaline, one-septate, not constricted, ends acute, 8–10 × 2–3 μ.

There would appear to be a possibility that this is identical with *Laestadia Traversi.*

A peculiar hyphomycete frequently occurs on Vanilla which has been killed by Soft Rot. In its fully developed form it consists of erumpent, cylindrical synnemata up to 0·3 mm. high and 0·2 mm. diameter, which expand at the apex into a fringed disc, 0·3 mm. diameter. The stalk is yellow, composed of parallel hyphae, and the disc whitish and convex. The marginal hairs of the disc are yellow-brown, septate, minutely spinulose, up to 100 μ long, 4–6 μ diameter, and terminate in an oval or clavate tip, 6–10 μ diameter. In many cases the stalk is wanting, and the disc is sessile or forms a slightly pulvinate sporodochium. The basidia are clustered at the apices of the conidiophores, and are fusoid, attenuated above, up to 18 μ long and 2 μ diameter. Each basidium terminates in a slender sterigma, which bears a single conidium. The conidia are hyaline, oblong-oval, one-septate, ends obtuse, 5–8 × 2 μ. This has been described (Ann. Perad., IX, p. 327) as *Actinostilbe Vanillae*, gen. et sp. nov. The hairs resemble the paraphyses figured by Delacroix for *Uromyces Joffrini.* Sydow (Mon. Ured.) states that there is no Uromyces on the specimen of the latter sent him by Delacroix. It may also be noted that Zimmermann described similar rough hairs as belonging to the *Colletotrichum* observed by him.

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EXPLANATION OF PLATES

PLATE III, Fig. 1. Vertical section of a stroma of *Botryosphaeria Vanillae*, from culture on Vanilla stem, × 70.

Fig. 2. Ditto, a single perithecium, seated on a stroma, × 70.

Fig. 3. Vertical section of a stroma of *Botryosphaeria Vanillae*, from culture on maize-meal agar, × 40.

Fig. 4. Section of a perithecium-like body, produced in maize-meal agar culture of *Botryosphaeria Vanillae*, × 75.

Fig. 5. Section through a group of perithecia of *Glomerella Vanillae* from culture on maize-meal agar, × 40.

PLATE IV, Fig. 1. *Volutella Vanillae*, conidiophores and seta.

Fig. 2. Ditto, conidia.

Fig. 3. *Botryosphaeria*, ascus.

Fig. 4. *Volutella*, germinated conidium, with appressorium.

Fig. 5. *Botryosphaeria*, germinating ascospore.

Fig. 6. *Glomerella Vanillae*, ascus.

Fig. 7. Ditto, extruded ascospores.

Fig. 8. *Glomerella Vanillae*, *Gloeosporium* conidium.

Fig. 9. Germinated conidium, *Gloeosporium* stage of *Glomerella Vanillae*.

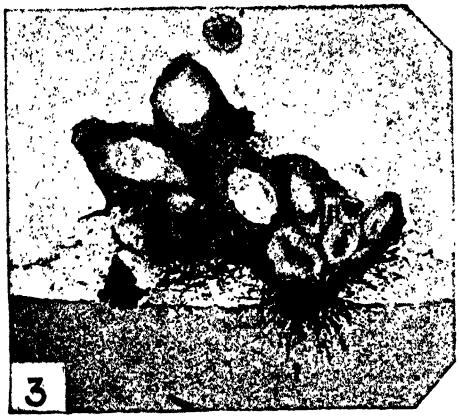
Fig. 10. Conidia of *Gloeosporium* species C (? *G. Vanillae* Cke.)

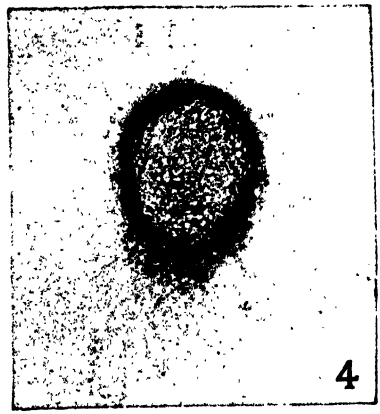
Figs. 11, 12. Ditto, germinated.

Fig. 13. Conidia of *Gloeosporium* species D.

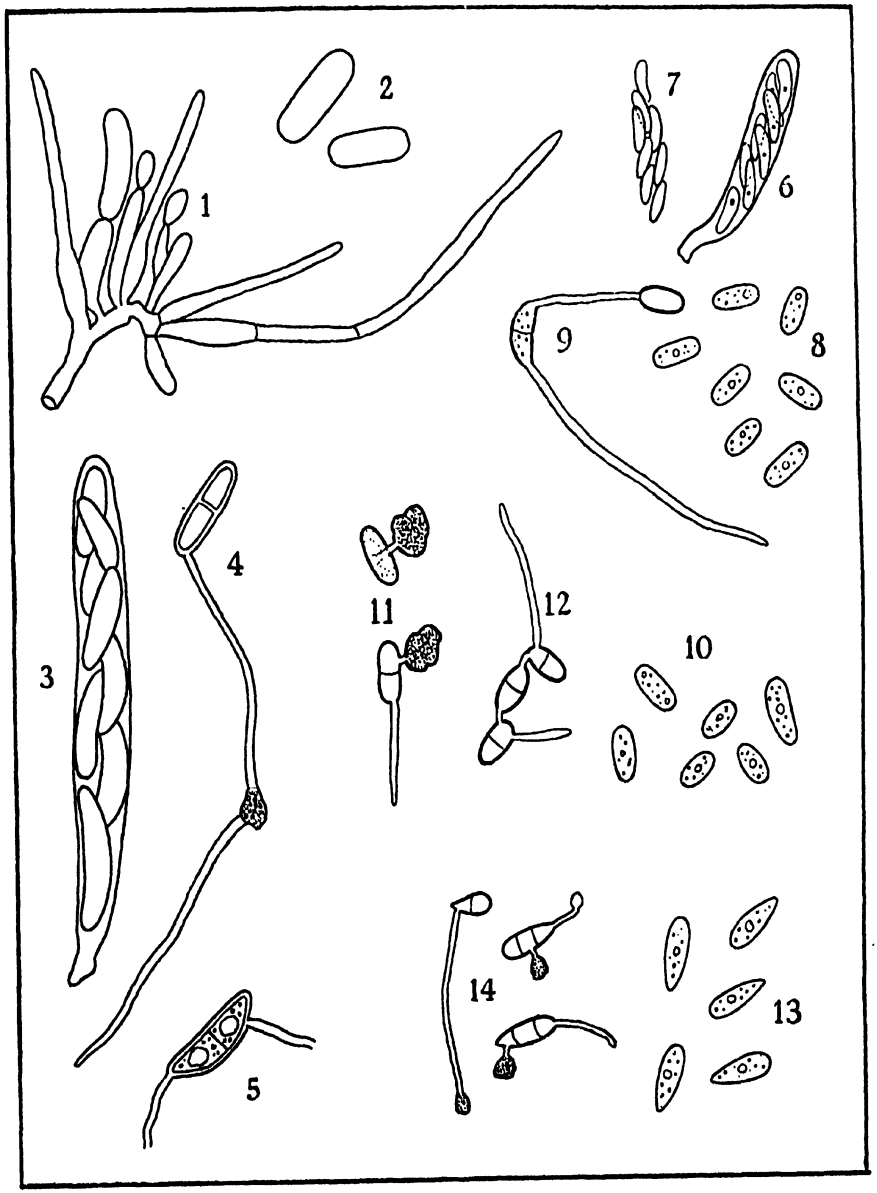
Fig. 14. Ditto, germinated.

[All figures on Plate IV, magnified 430 diameters.]





Vanilla Fungi



Vanilla Fungi

Grey Blight of Tea and Coconut—A Comparative Study

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WITH SIX PLATES

The leaf diseases of tea and coconut which are known as Grey Blight are caused by species of *Pestalozzia*, but there has been considerable difference of opinion concerning the identity of these fungi. Consequently, the following comparative study of the Pestalozzias on the two plants has been undertaken.

Typical *Pestalozzia* spores on tea and coconut leaves (Plate VIII, figs. A, B.) are spindle-shaped or fusiform bodies, divided by four septa into a row of five cells, of which the three central are dark coloured, often pale brown, and the terminal cells hyaline. The apical hyaline cell is crested with hyaline cilia, or thread-like appendages, of varying length, which are probably of assistance in dissemination. Each spore has usually three cilia, but the number may vary from 2 to 4. To the lower hyaline cell is usually attached a pedicel or stalk on which the spore is borne. Abnormalities occur in the size of the spore and the number of coloured cells.

Work was chiefly concentrated on the size of the spores and the behaviour of the fungus when grown in culture. Pure cultures were obtained several times from diseased leaf spots by single spore isolations from poured plates. Spores from a single pustule were picked out with a pointed needle under a dissecting microscope, shaken in a little sterile water, and the material plated in Dextrose-meat extract agar. Spores from the same pustule were then carefully examined under the microscope to make sure that the pustule consisted of spores of the same variety as those plated. On the following day the spores had germinated in the medium. Those which were found isolated were picked out with a small piece of the culture medium and transferred to Maize-meal agar slants. Thus all the cultures were started from single

spores. Sub-cultures were made, as a rule, by transferring spores from tube to tube. Spores were grown in distilled water and standard nutrient solution in drop culture, a series of cultures being made in each case; on tea and coconut leaves, sterilized by boiling, in Roux tubes, and in various culture media; but for the purpose of comparison Oat agar, Maize-meal agar and French-bean agar were selected. In comparing the behaviour of the fugus that attacks tea with that of coconut the culture media were inoculated with each *Pestalozzia* on the same day, so that they were of the same age and grew under the same conditions.

Examinations of the fructification in the leaf and in culture were made by fixing the material in Chrom-acetic acid, embedding in paraffin, and microtoming. Gentian violet in 1% solution in water was used to stain the cilia in order to determine whether they were inflated at the tip (knobbed) or not.

The mean dimensions given in this paper were derived from measurements of fifty spores in each case. To ensure accuracy all measurements were made with the $\frac{1}{12}$th. inch objective and the drawings with the aid of a camera lucida.

GREY BLIGHT OF TEA

History.—Grey Blight of tea is one of the commonest leaf diseases of tea in Ceylon and appears to occur in all tea-growing countries. Massee, in Kew Bulletin 1898, p. 106, reported on Grey Blight of tea from material sent by Dr. Watt from Assam. He stated "An examination of the fungus sent from Assam on leaves of tea plant showed it to be identical with the parasite common on leaves of cultivated species of *Camellia* in Europe." He ascribed the disease to *Pestalozzia Guepini* Desmaz. This was the first scientific description published on Grey Blight of tea. It had been known in Assam many years before this, for in the same report Massee stated, "This disease under consideration is by no means new; specimens of tea leaves attacked by the *Pestalozzia*, now in the Kew Herbarium, are accompanied by the following note: 'Tea leaves (blighted), Cachar, 1872 growth, A. H. Blechynden.' A second lot of the leaves, suffering from the same disease, is accompanied by a note as follows: 'Leaves from a tea tree recovering from 'red spider,'.....T. B. Curtis. Received from Mr. Blechynden, Calcutta, by T.B.C., October, 1878.'

In 1899, Willis, then Director of the Royal Botanic Gardens, Ceylon, in a circular of the department on "Tea Blights" stated "This disease is due to the attack of a parasitic fungus known to science as *Pestalozzia Guepini*. It attacks tea in Assam, from which country it has very

probably been imported with tea seed." In 1907, Bernard in his paper "Sur quelques maladies de *Thea assamica*, de *Kickzia elastica* et de *Hevea brasiliensis*" ascribed Grey Blight in Java to *Pestalozzia palmarum* Cooke. In 1915 Sawada published his diagnosis of *P. Theae* as the cause of the Grey Blight of tea in Formosa. In 1916, in the Annual Report of the Government Botanist of the Uganda Protectorate Grey Blight of tea in that country is ascribed to P. *Guepini*. In 1918, Butler, in Fungi and Disease in Plants, p. 451, gave the cause of Grey Blight of tea in India as *P. Theae* Sawada. In a foot note he stated "Specimens on tea from India, Ceylon and Formosa were compared by the author at Kew, in 1914, with the type specimen of *P. palmarum*, and with Desmazières' specimens of *P. Guepini* from the type locality (Angers). The three fungi were found to be distinct. Subsequently (1915), Sawada published his diagnosis of *P. Theae* and specimens kindly communicated by him are identical with the Indian and Ceylon material."

The disease in nature.— The disease first appears on the upper surface of the leaves as minute yellowish spots which soon turn brown. These spots gradually increase in size, turn grey and often coalesce forming large irregular patches extending over the leaf. When the attack occurs near the margin of the leaf it generally spreads along the whole length of the margin. These patches are greyish in colour on the upper surface, and in some cases almost white, bounded by a ring dark-brown in colour. Outside this ring there is often a translucent band shading into the green healthy part of the leaf. The under surface of the diseased patch does not turn grey but is of a light-brown colour. The fructifications of the fungus appear as minute black dots on the grey patch on the upper surface of the leaf. They are usually scattered irregularly over the whole surface, but very often they are arranged in beautiful concentric zones chiefly at the edge of the patch. The fructifications also occur on the lower surface, but this is of rarer occurrence and when present comparatively few pustules are seen. When diseased leaves are plucked and placed in a moist chamber the spores are often exuded in the form of a black tendril. This appears to be chiefly due to the greater humidity under such conditions. Leaves taken from naturally-grown (*i.e.* unpruned) tea bushes under shade also showed this behaviour.

When a diseased patch is examined with a lens the epidermis of the leaf where the fructification occurs is seen raised and cracked, the crack being longitudinal, star-shaped or diamond-shaped. In microtome sections the spores are seen to be formed in pycnidia which are

bowl-shaped, lenticular, or elliptical, varying in width from 0·13 mm. to 0·33 mm., and isolated or more rarely aggregated. The pycnidia are sub-epidermal. Each pycnidium is completely closed by a pseudo-parenchymatous wall and has no ostiolum. It has a distinct basal wall, but thin and obscure upper and lateral walls. Spores are borne on pedicels or stalks 5–10 μ long and less than 1 μ diameter from a layer of cells in the basal wall. The pedicel is filiform, straight, or slightly curved, not separated from the spore by any cross wall, and is really a portion of the spore. When the spores are mature they are detached with the pedicel. The mass of spores forces up the epidermis and the thin pycnidial wall underlying it, and by finally rupturing both is liberated to the exterior. If sufficient moisture is present at this time they often ooze out in the form of a black tendril.

An examination of spores from diseased leaf spots gave the following results. The spore, including the terminal hyaline cells but not the pedicel or cilia, measured from 20 to 35 μ, with a mean of 25·6 μ; the coloured cells 15–22 μ, mean 18 μ; width 5–8 μ, mean 6·7 μ. The cilia or appendages were very long varying in length up to 40 μ, the maximum breadth at the base being about 1–1·5 μ; each terminated in a blunt knob. Each spore has usually 3 cilia, but the number varies from 2 to 4. The pedicel or stalk is persistent, straight or slightly curved to one side, and varies in length from 5–10 μ. One abnormal spore was seen having 5 coloured cells—the coloured cells measuring 25 × 6 μ and the whole spore, including the terminal hyaline cells, 33 × 6 μ. (Plate VIII, fig. A.) The hyphae penetrating the host were hyaline, septate, finely branched and generally difficult to trace, and 2 to 3 μ in width.

One peculiarity about this fungus is that its attack is usually confined to the old, hard leaves of the bush. The younger leaves are sometimes affected, but very rarely. The disease is prevalent mainly on neglected plantations, or when the bushes lack vigorous growth due to various causes as undrained sour soil, want of sufficient plant food, water-logging, or scarcity of water, or any cause that would render the bush weak.

CULTURES

Pure cultures of the *Pestalozzia* were got by placing leaves affected by the disease in a moist chamber for two days, when the spores were liberated from the pycnidia and appeared quite prominent as a small black mass on the surface. Very often they were extruded in a black tendril.

Spore germination. On germination the lowest of the three coloured cells usually produces a germ tube. This coloured cell is the germ-cell; before germination, it swells up, gradually loses its brown colour turning almost hyaline, becomes nearly spherical, marked very often by a light ring round the middle, and then puts out one, or sometimes two, germ tubes from the side. *In distilled water*, when the culture was four hours old, the lowest coloured cell in a large number of spores had swollen, and become spherical and almost hyaline preparatory to germination. Some spores had pushed out germ tubes from the sides, up to 20 μ long and nearly 3 μ wide at the base. In some spores that had germ tubes nearly 15 μ long, the germ-cell was seen to have undergone no change in colour or size, a distinct crack being present in the wall where the germ tube emerged. When a culture seventeen hours old was examined, the spores were found to possess, as a rule, one germ tube, non-septate or sparingly septate, emerging from the side of the usual germ-cell. Spores were also seen possessing two germ tubes arising from the same side of the germ-cell (Plate IX, fig. 2), or very rarely one on each side. In a culture twenty-four hours old the germ tubes were septate and branched. One spore had germinated in an unusual manner by pushing out a germ tube, which branched at the base, from the side of the uppermost coloured cell. A few spores had undergone no change whatever; in others the germ-cell was just beginning to lose colour and swell, while in others very short germ tubes were present. *In nutrient solution* spores had begun to germinate in about four hours. The mode of germination was similar to that in distilled water, but the growth was decidedly more luxuriant. In some spores the germ-cell had swollen to a width of 10 μ, and the germ tube was stouter than in water cultures and varied in width from 2·5 to 5 μ. It was also more branched, and more septate with distinct constrictions at the septa. As in water, in a culture twenty-four hours old a few spores had undergone no change, while some were preparing to germinate and others had very short germ tubes. The time normally taken for a *Pestalozzia* spore to germinate is therefore about four hours, but from the fact that some spores do not germinate within twenty-four hours in water or in nutrient solution it would appear that other factors, possibly age, may delay germination. When spores from single pustules from the leaf in nature or from culture media are taken for germination it does not necessarily follow that they are of the same age, although they originate from the same pustule.

Spores were grown in pure culture in Maize-meal agar, French-bean agar and Quaker oat agar. Details of growth on these media are given below.

Oat Agar. The slants were inoculated with spores from a Maize-meal culture. On the third day hyphae radiate from the point of inoculation for a distance of about 1 cm., and are confined to the surface of the medium. Aerial growth now begins, the mycelium appearing woolly and compact. The mycelium shows zoning but it is not very distinct owing to the rich growth of hyphae; the zones are approximately 2 mm. broad. The culture medium begins to change to an orange tint. In six to eight days the fungus overruns the whole surface of the medium with a rich aerial woolly mycelium and spreads over the glass in compact form. On the ninth day the mycelium as a whole presents a pinkish tinge and the medium itself a darker orange tint than it first possessed. On the twelfth day spores begin to be formed on the hyphae running along the inside of the glass above the culture medium. (Plate VIII, fig. E.) On the thirteenth day the mycelium is a loose, thick, heavy, pinkish felt lying on the medium, while the medium itself appears salmon-pink in colour. With age the pinkish colour of the mycelial felt and the salmon-pink colour of the medium gradually fade, and the hyphae which are growing on the glass, to such an extent as to almost fill the tube, appear as a continuous black mass owing to the innumerable spores borne on them. In some slants black bodies appear on the culture medium at about the same time as spores are formed on the hyphae in other tubes. Underneath some of these bodies a black longitudinal thread penetrates into the medium. These threads are masses of spores extruded in tendril form into the culture medium; they may be up to 4 mm. long.

Microscopic examination. Pieces of the culture medium containing these black bodies were microtomed. In microtome sections these bodies are found to be pycnidia and pseudo-parenchymatous stromata containing pycnidial cavities. In the culture medium a stroma composed of interwoven hyphae is present, 0·26 mm. to 0·52 mm. deep. Pycnidia are found in the felt of mycelium on the medium, or on the stroma (*i.e.* on the surface of the culture medium), or within the stroma in the medium, or in the medium itself. The pycnidia vary in size and shape. They are spherical, spherical and chambered, sub-globose, or oval, completely closed by a pseudo-parenchymatous wall which is never more than 40 μ thick. The spores are borne on the wall and are liberated by a rupture of the wall at any point. They may emerge into the air, or into the stroma in the culture medium, or into the culture medium itself. The following examples are cited in illustration of the variation in the shape of the pycnidium and the liberation of the spores:

(*a*) *Pycnidium formed in the stroma.* Spherical, 0·26 mm. diameter : stroma slightly raised owing to the presence of the pycnidium ; pseudo-parenchymatous wall 20 to 40 μ thick ; spores liberated into the medium below by a rupture of the wall at the base, and filling an oval cavity 0·34 mm. long and 0·26 mm. wide in the medium (Plate V, fig. 6).

(*b*) *Pycnidium on the stroma.* Globose, 0·73 mm. wide and 0·52 mm. high, stroma slightly raised beneath the pycnidium so that the pycnidium appeared elevated on a cushion ; pseudo-parenchymatous wall 12 to 40 μ thick. Spores liberated by an aperture 0·13 mm. wide at the base into the culture medium where they filled an oval cavity 1 mm. long and 0·69 mm. wide. (Plate V, fig.1).

(*c*) *Pycnidium in the felt of mycelium on the medium.* Spherical, chambered, diameter about 0·78 mm.; wall 12 to 30 μ thick ; spores liberated into the air by a break in the wall at the top.

(*d*) *Pycnidium in the culture medium.* Spherical, chambered, diameter 0·22 mm. ; wall 10 to 40 μ thick ; spores liberated into the medium.

(*e*) *Pseudo-parenchymatous stroma.* Stromatic body somewhat globose. 0·91 mm. wide and 0·52 mm. high, present on the stroma formed in the medium, exhibiting in section 4 pycnidial cavities of various sizes ; one of these opened at the top and another at the side, liberating spores to the exterior ; the third opened at the base liberating spores into the culture medium, and the fourth opened into the stroma of the culture medium. (Plate V, fig. 3).

Spores. The length including the terminal hyaline cells was 22–36 μ, mean 27·4 μ; the coloured cells, 16–23 μ, mean 18·4 μ; width 6–8 μ, mean 6·9 μ; pedicel, 3 to 10 μ long and about 1 μ diameter; cilia, 2 to 4, generally three, up to 42 μ long, 1–2 μ diameter; apex of the cilia knobbed or not. Spores borne in pycnidia generally had the cilia knobbed, very rarely not knobbed, while those borne on free hyphae were generally not knobbed, though in many cases distinct swelling was visible at the apex. Spores with unknobbed cilia, when transferred to tea or coconut leaves, sterilised by boiling, in a Roux tube, readily formed knobs, while

those that already had knobs when grown on oat agar continued to produce cilia with knobs when transferred to tea or coconut leaves. The diameter of the hyphae was 2 to 3 μ. Free hyphae which bore spores were generally 3 μ diameter. Some hyphae were present, 4 μ diameter, constricted at the septa, frequently septate, much branched, and filled with fat globules. Lateral union of the hyphae is very common in culture. Stout hyphae may give rise to very fine branches. Submerged hyphae may be profusely branched and irregularly swollen, with swellings up to 6 μ diameter.

French-bean agar. The agar slants were inoculated with spores from a Maize-meal culture. On the fourth day the hyphae have grown for about 1 cm. from the point of inoculation, in a patch which is hardly perceptible and have then formed a band of aerial, woolly, compact hyphae, 1·5 cm. broad. This band extends from day to day until on the eighth day it reaches the end of the tube. The hyphae ascend the sides of the glass for about 4 mm. The mycelial growth as a whole is a white, smooth, felted layer with a heavy thick appearance lying on the medium. With age the medium changes to a brownish orange colour. On the eleventh day small greyish or blackish protuberances are seen in the white felted layer and underneath the felt too black bodies about the size of pin heads are seen scattered about. On the sixteenth day spores begin to be formed on the hyphae on the sides of the glass. In some tubes, instead of a continuous layer of aerial hyphae on the medium, successive bands of hyphae occur; the intervening spaces ultimately become filled up with aerial hyphae, forming a continuous felt.

Microscopic examination. The small blackish protuberances in the felted layer and the black bodies underneath it, when examined under a microscope are found to be pseudo-parenchymatous, composed of faintly yellowish cells. In microtome sections these bodies are found to be pycnidia and pseudo-parenchymatous stromata containing pycnidial cavities. A stroma composed of interwoven hyphae is present in the culture medium, varying in depth from 40–120 μ. Pycnidia are found on the stroma, or embedded in the stroma partly or completely, and a few in the felt of mycelium on the medium. The pycnidia are of various shapes and sizes, flask-shaped, globose, spherical and sometimes chambered, completely enclosed by a pseudo-parenchymatous wall which may be of uniform thickness or may vary in thickness in a single pycnidium. Spores are borne from a layer of cells on the wall and are liberated by a rupture of the wall at the base into the

culture medium, or at the top or sides to the exterior. Pseudo-parenchymatous stromata originate as small cushions on the stroma in the medium and are of various shapes. One or more pycnidial cavities may be present in each. The following are examples of the various forms of pycnidia, etc.

(*a*) *Pycnidium formed on the stroma.* Flask-shaped, height 160 μ greatest width 150 μ, no ostiolum, thickness of wall 20 μ, at the base 40 μ; spores borne on the sides of the wall but mainly at the base, and liberated by a rupture of the wall at the apex. (Plate V, fig. 4.)

(*b*) *Pycnidium partly embedded in the stroma.* (1) Globose, width 160 μ, height 120 μ, completely closed; wall between 10–20 μ thick, at the base 25 μ; spores borne from all sides of the wall and liberated to the exterior by a rupture of the wall at the top. (2) Globose 0·33 mm. wide and 0·26 mm. high; wall 20 μ thick; spores liberated by a rupture of the wall at the base into the culture medium and forming a tendril of spores 0·39 mm. long and 0·13 mm. wide.

(*c*) *Pycnidium completely embedded in the stroma.* Spherical, diameter 200 μ; wall 10 to 40 μ thick.

(*d*) *Pseudo-parenchymatous stroma.* Stromatic body almost globose in shape, 0·52 mm. wide and 0·39 mm. high; exhibiting in section four pycnidial cavities of different sizes; wall of cavities 20 to 40 μ thick.

Spores. The length including the terminal hyaline cells was 22–33 μ, mean 27·3 μ; coloured cells 16–20 μ, mean 18·2 μ; width 6–8 μ, mean 6·7 μ; pedicel 5–10 μ long and about 1 μ diameter; cilia 2–3 and up to 45 μ long. Spores with knobbed and unknobbed cilia were both present in the culture; the latter when grown on sterilised tea or coconut leaves readily produced knobs. The hyphae were hyaline, septate, branched and 2–3 μ diameter, those bearing spores being 3 μ diameter. Old hyphae were distinctly constricted at some of the septa. Some of the hyphae were 4 μ in diameter.

Maize-meal agar. The agar slants were inoculated with spores from a Maize-meal culture. On the third day hyphae have grown from the centre of inoculation for about a centimetre in an almost imperceptible patch on the medium and have then formed an aerial growth presenting the appearance of a white puff standing erect on the medium. On the following day the hyphae have spread from this puff for about another

centimetre along the surface of the medium and have then formed another puff of aerial hyphae. The formation of puffs at regular intervals takes place till the bottom of the test-tube is reached. As the culture advances in age the intervening spaces between some of the puffs are gradually filled up with hyphae so that the growth as a whole presents a woolly appearance. When the culture is twelve days old the interior hyphae of the woolly puffs appear greyish or blackish in colour owing to masses of spores which are formed on the loose hyphae. Hyphae also grow along the glass up the sides of the test-tube for about a centimetre in a compact form and bear spores in abundance. In some tubes black bodies, up to 4 mm. in diameter, consisting of a mass of spores, appear under the woolly growth.

Microscopic examination. In microtome sections the black bodies are found to be pycnidia with their extruded spores. No definite stroma is present in the culture medium, but a loose network of hyphae or pseudo-stroma, 0·26 mm. to 0·39 mm. deep, extends from the surface of the medium inwards. The pycnidia vary in size and shape, being spherical or oval, 0·2 to 0·78 mm. high and 0·2 to 0·46 mm. diameter, and either simple or chambered. (Plate V, figs. 2, 5). They are scattered or clustered, some being united, with a common wall at the point of union. They may be superficial, slightly embedded in the pseudo-stroma, or completely immersed in the latter. The pycnidia which were embedded in the pseudo-stroma were spherical and not chambered. The pycnidia are completely closed by a pseudo-parenchymatous wall which varies in thickness from 15 to 25 μ in different pycnidia. In some pycnidia the thickness of the wall is variable, while in others it is uniform. Spores are borne on the wall and are liberated by a rupture of the wall at the top or side. Spores which are liberated from pycnidia situated on the pseudo-stroma are unable to reach the surface owing to the presence of the woolly felt. (Plate V, fig. 2). In rare cases they broke through the felt and spread over the top of it.

Spores. The length including the terminal hyaline cells was 22–32μ, mean 26·6 μ; the coloured cells, 15–20 μ, mean 18·5 μ; width 6–8 μ, mean 6·8 μ; pedicel, 3–7 μ long and about 1 μ diameter; cilia, 2–3 up to 40 μ long and from 1 to 2 μ wide, apex knobbed or not knobbed. The spores borne in pycnidia had knobbed cilia, while those borne on the free hyphae had cilia not knobbed. Spores with unknobbed cilia when grown in Roux tubes on sterilised tea and coconut leaves readily formed knobs. The hyphae were hyaline, septate, branched, and 2–3 μ in diameter; those bearing spores were about 3 μ diameter. Some hyphae were up to 5 μ in diameter.

The following table gives the dimensions of spores in nature and on the various culture media :—

Media.	Range of length including terminal hyaline cells.	Mean length.	Range of length of coloured cells.	Mean length.	Range in width.	Mean width.
Tea leaves in nature.	20–35 μ	25·6 μ	15–22 μ	18·0 μ	5–8 μ	6·7 μ
French-bean agar.	22–33 μ	27·3 μ	16–20 μ	18·2 μ	6–8 μ	6·7 μ
Oat agar.	22–36 μ	27·4 μ	16–23 μ	18·4 μ	6–8 μ	6·9 μ
Maize-mealagar.	22–32 μ	26·6 μ	15–20 μ	18·5 μ	6–8 μ	6·8 μ

The chief feature on all the three media is the rich fluffy growth of aerial hyphae, which ultimately forms a thick, heavy, compact felt of white mycelium lying on the medium. No formation of tufts of hyphae occurs. In the French-bean agar and Oat agar a stroma is formed in the culture medium, but in the Maize-meal agar there is only a loose network or pseudo-stroma in the medium.

Spores were borne in pycnidia and in pseudo-parenchymatous stromata containing pycnidial cavities. In all the three media the pycnidia were mainly present on the stroma or pseudo-stroma, and very few in the felt on the medium. They were of various shapes and sizes, completely enclosed by a pseudo-parenchymatous wall and had no ostiolum, the spores being liberated by a rupture of the wall anywhere. In a large number of cases the spores were liberated into the stroma or culture medium by a rupture of the wall at the base, and formed a mass of mature spores in a cavity in the stroma or medium as the case may be. In addition to the production of spores in pycnidia, spores were also borne in large numbers on the free aerial hyphae.

In all the three media the spores possessed very long cilia of varying length, some in the French-bean culture attaining lengths of 45 μ. The cilia varied in number from two to four. The majority of the spores in culture had the cilia knobbed, but many were not knobbed. These spores with unknobbed cilia when transferred to tea or coconut leaves

sterilised by boiling in a Roux tube readily formed knobs. The length of the pedicel varied from 3 to 10 μ.

Spores were also grown in pure culture in Tea leaf-juice agar, though not for the purpose of comparative growth, but it is of interest to note that some spores in this culture medium germinated from the apical hyaline cell. Germ tubes were seen in various stages of growth, non-septate, or septate and branched, and varying in diameter from 2 to 2·5 μ. One spore had a non-septate germ tube 65 μ long and 2 μ diameter at the base with a small branch at one side. Another had a germ tube 70 μ long and 2 μ diameter and with only one septum. One abnormal spore produced in this medium had only 2 coloured cells, while another spore had 4 coloured cells, the whole spore measuring 37 × 6 μ. The cilia were very long and some attained 55 μ in length.

INOCULATIONS

(A) On tea.

(1) Four tea leaves were plucked, washed with distilled water, spores previously mixed with a few drops of standard nutrient solution placed on them and kept in a moist chamber. Twelve inoculations were made, 6 on the upper surface and 6 on the lower. On examination a fortnight later no trace of infection was evident. The control was free.

(2) Tea plants about 6 inches high, growing in a pot, were inoculated in the following manner. Spores from a Maize-meal culture were grown in standard nutrient solution in drop culture. After 24 hours a large number of spores were found to have germinated. The cover glass with the drop then was placed on the leaf and the plants were covered with a bell glass. 8 inoculations were made on the upper surface. When examined microscopically 18 days later there was no trace of penetration. The inoculated leaves were kept moist from the third day after inoculation by pouring cold sterilized water on them. The control was free.

(3) Four tea leaves were washed with distilled water, and wounded by shaving off a small area of the epidermis with a razor. They were then inoculated with mycelium and spores from a pure culture of Maize-meal and placed in a moist chamber. Six inoculations were made in all, three on the upper surface and three on the lower. When examined 11 days later, 4 inoculations were found to have taken. In two cases fructifications were present.

(4) Tea leaves were washed with distilled water, wounded by pricking with a sterilized needle and placed in a moist chamber, 9 wounds being made, 6 on the upper surface, and 3 on the lower. The wounds were then inoculated with mycelium and spores from a culture on

Maize-meal agar. Three days after inoculation the area round the wounds began to discolour. Examined microscopically 13 days after, all the inoculations were found successful except one. One leaf which was inoculated in two places took infection very well. On a leaf which had three inoculations, one wound which had an original area of 5 mm. by 5 mm. extended to 3 cms. by 2 cms.; a second wound from 4 mm. by 4 mm. extended to 10 mm. by 8 mm; while the third wound from 4 mm. by 3 mm. extended to 5 mm. by 4 mm. On one leaf inoculated in three places a rot set in from two wounds and extended along the edge practically covering three-quarters of the area of the leaf, but the third inoculation was unsuccessful. Spores were produced in abundance from pustules. On a leaf which had only one inoculation, the original area of 3 mm. by 3 mm. extended to 5 mm. by 4 mm. The control was free.

(5) Seven inoculations were made on the under surface of leaves of a tea bush in the open, both old and young leaves being selected for inoculation. Pieces of Maize-meal culture containing spores and mycelium were used, and moist cotton wool was placed over the inoculum, one or more leaves being enclosed in a large glass tube, of which the open end was plugged with cotton wool. Before inoculation the leaves were washed with sterilized water. Examined 15 days later, all the inoculations were found to have failed.

(6) In the following experiment hyphae only from a luxuriant growth from a Maize-meal culture were used. The leaves were first washed with 0·1 per cent corrosive sublimate and then with distilled water. (1) Three inoculations were made on the upper surface, a piece of the culture medium containing the hyphae being placed on the leaf, a pad of moist sterile cotton wool over it, and then a piece of wax cloth, the whole being secured to the leaf by a slide-on clip. (2) Three inoculations were made on the under surface in a similar manner. (3) Three inoculations were made on petioles of half grown leaves and three on petioles of mature leaves, but in this case only moist cotton wool was used without the wax cloth. All the inoculations were made on a bush in the open, and the whole bush was covered with a cage of jute hessian to keep off sunlight. From the 4th day after inoculation the cotton wool was kept moist by wetting with sterilized water. When carefully examined 24 days later, all the inoculations were found to have been unsuccessful. The leaves chosen for experiment included both mature and half mature ones.

(7) The leaves of plants about 6 inches high were washed with sterilized water and inoculated on the under surface with a Maize-meal agar culture. Over each piece of the culture was placed a piece of cotton wool moistened with distilled water. Young and old leaves were selected

for inoculation. Nine inoculations were made in all. The plants were in a pot and covered with a bell glass. When examined 24 days later there was no trace of any infection.

(8) Full-grown tea leaves on a bush in the open were washed in 0·1 per cent corrosive sublimate and then in distilled water and inoculated on the under surface from a Maize-meal agar culture. The culture was growing vigorously and it possessed a good crop of spores. Spores and mycelium, with a small piece of the medium were used for inoculation. Five inoculations were made. The branch bearing the inoculated leaves was enclosed in a gas cylinder and the open end plugged with cotton wool. When the inoculations were examined 20 days later, no infection could be observed.

68 inoculations were made in all,—17 on the unwounded upper surface of the leaf, 30 on the unwounded lower surface, 15 on the leaf after wounding, and 6 on the petioles. The inoculations on the uninjured upper and lower surfaces of the leaf were all unsuccessful, while out of the 15 inoculations on the wounds 12 were successful; those on the petioles were all failures.

(B) On coconut.

(1) Coconut seedlings about 2½ ft. high were selected for this experiment. Prior to inoculation the leaves were washed in 0·1 per cent corrosive sublimate and then in distilled water. Inoculations were made on the under surface of the leaves, 14 on the uninjured leaf and 6 after wounding—the wounds being caused by gently scraping the epidermis with a needle lengthwise and crosswise so as to cover an area of about 4 mm. × 4 mm. The inocula used were small pieces of Maize-meal agar culture containing hyphae and spores. The inoculated leaves were enclosed in large gas cylinders supported on tripods and the open ends plugged with cotton wool. Three days later signs were evident of the wounded inoculations taking in all cases. The original wounded patch turned greyish on the upper surface, with a translucent band outside it shading into the green. The grey patch then became bounded by a reddish-brown margin about 0·8 mm. wide, while in the translucent band fine light-brown rings could be seen when examined carefully. 13 days after inoculation the diseased area showed a central grey patch surrounded by a reddish-brown zone about 0·8 mm. wide, then a translucent band about 1·8 mm. wide possessing two lighter brown concentric rings, and outermost, another reddish-brown zone slightly narrower than the one surrounding the grey patch. Here the fungus appeared to stop its growth and it did not proceed further during the four weeks it was kept under observation. All the 6 inoculations behaved practically in a similar manner, except two, which did not

show any concentric rings in the translucent band. Though the inoculations were successful the progress of the disease was very slow and limited. The unwounded inoculations were all failures. The control was free.

(2) Old and hard leaflets were chosen for inoculation. They were cut into lengths of about 5 inches, washed in sterile water and placed in a moist chamber. The undersurface was inoculated with pieces of the culture medium bearing abundant masses of spores from a fresh culture. Ten inoculations were made, but all were found to have failed when examined 22 days afterwards. The control was free.

In all, 30 inoculations were made on the lower surface of the leaf, 24 on the uninjured leaf and 6 after wounding. Only the latter were successful.

GREY BLIGHT OF COCONUT

History. Grey Blight is the common leaf disease of coconuts in Ceylon and appears to be equally common wherever coconuts are cultivated. Plant pathologists are generally agreed that the fungus responsible for the damage is *Pestalozzia palmarum* Cooke. In 1889 Drieberg investigated a leaf disease on coconuts in Ceylon. This disease was most probably Grey Blight, though the fungus was not identified. In the same year Potter examined coconut leaves attacked by the same disease and found a fungus which he thought was a *Phragmidium*. It is possible that the latter fungus was *Pestalozzia*. In 1900 Raciborski reported the disease for Java. In 1901 Busck reported a leaf disease in Cuba and the fungus was identified by Woods and Mrs. Patterson. In 1905 Ch. Bernard found the fungus doing damage in Java. In 1906 Petch reported the disease in Ceylon and Stockdale in Trinidad. In 1908 Butler found the disease in Travancore. Barret in 1912 and Baker in 1914 recorded the disease for the Philippines. In 1917 Richards reported the disease in the F.M.S. A study of this fungus was made to ascertain its real identity by comparison with the type at Kew and to compare this species with that on tea.

The disease in nature. The disease first becomes noticeable by the appearance of small, translucent, yellowish spots, more or less regular in shape, scattered about the leaflets. The spots gradually increase in size, and may remain isolated, or may run into one another, forming irregular patches which are at first yellowish and finally greyish white, edged by a dark-brown line, outside which is a ring of pale-green or yellow tissue. The diseased patch very frequently extends longitudinally, eventually covering the greater portion of the surface of the leaflet. It is difficult to say on which side of the leaflet the discolouration first appears,

but the pale yellow, and later the greyish discoloured areas are equally evident on both surfaces; these areas are shrunken and thinner than the healthy portions. It was invariably seen on leaflets which bore diseased spot, that the tips of the leaflets had the disease in an advanced stage, indicating that these parts were first attacked and that the fungus spread from them to the other parts of the leaf. When a large number of diseased spots have made their appearance, the whole leaf assumes a yellowish appearance and gradually becomes greyish and withered. The diseased patches crack, fall off easily, and appear ragged, especially along the edges. The older leaflets are chiefly affected; the central shoot is little affected except in very bad cases.

On examination of a diseased patch with a lens minute protuberances can be seen scattered irregularly all over the upper surface. The epidermis of the leaf where these protuberances occur is raised and cracked in a longitudinal or triangular manner, and in the centre of the crack a gray or black body is seen which is a mass of spores.

Attempts were made to cause these spores to issue in tendril form by placing diseased leaves in a moist chamber, but no success was attained.

In microtome sections these protuberances are found to be pycnidia, which are globose or lenticular, simple, gregarious, or scattered, varying in diameter from 0·13 mm. to 0·42 mm., situated chiefly on the upper surface of the leaf, very rarely on the lower surface. The pycnidia are sub-epidermal. Each pycnidium is completely closed by a pseudo-parenchymatous wall and has no ostiolum. It has a distinct basal wall up to 20 μ thick, and thin, often obscure, upper, and lateral walls up to 10 μ thick. The spore is borne on a pedicel or stalk, 2 to 5 μ long and less than 1 μ diameter, from a layer of cells on the inner wall of the lower half of the pycnidium. When the spores are mature they are detached with the pedicel, and are liberated by a rupture of the upper wall of the pycnidium and the epidermis overlying it.

An examination of spores from diseased leaf spots in the field gave the following results:—The spore, including the terminal hyaline cells but not the pedicel or cilia, measured from 15–25 μ in length, with a mean of 20·2 μ; the three coloured cells 12–16 μ, mean 13·8 μ; width 5–7 μ, mean 5·7 μ. The cilia or appendages terminated in a knob and varied in number from 2 to 3, but spores with four cilia were occasionally present. The cilia were generally about 20 μ long, but few spores were seen with cilia as much as 40 μ long. The pedicel or stalk varied in length from 2 to 5 μ (Plate VIII, fig. B). One abnormal spore was seen having 5 coloured cells, and another with 4 coloured cells. The hyphae penetrating the host were about 2 μ diameter, hyaline, septate

and finely branched, running between the cells. In sections no hyphae could be traced beyond the brown line surrounding the diseased patch. It would appear that this line marks the limit of damage done to the leaf.

Young as well as old palms are susceptible to the disease, but bad cases of attack generally occur on young palms. The disease is widespread and often assumes a virulent form on weak and neglected trees. No case has yet been reported of a palm having been killed by this disease.

CULTURES

Pure cultures of the fungus were obtained by cutting diseased leaflets from the field into suitable sizes of about five inches in length, washing them in 0·1% Corrosive Sublimate solution and then in distilled water, and placing them in a moist chamber for about forty-eight hours to soften the affected patches and facilitate the removal of spores.

Spore germination. Spores were sown in distilled water and nutrient solution in drop culture for germination study. In both these media the lowest of the three coloured cells was the germ-cell, and produced one or two germ tubes.

In distilled water when the culture was two and a half hours old, few spores showed the germ-cell becoming colourless and spherical, and when four hours old germ tubes 12 to 50 μ long and 1·5 to 2·5 μ diameter were seen protruding from the sides. In a culture five hours old one spore had two germ tubes coming out close to each other on the same side of the germ-cell. In a culture twenty-four hours old the majority of the spores had germinated (Plate X, figs. 11, 12, 13), sending out generally one germ tube which often branched at the base, but occasionally two, one on each side of the germ-cell. The germ tubes were sparingly branched and sparingly septate. In some cultures a good number of spores had undergone no change, while others had the germ-cell spherical and swollen but had not germinated. The time taken, therefore, for a spore to germinate in water is usually about four hours, but the time of germination really depends on the individual spore. *In nutrient solution* early germination was more general and the growth of the pro-mycelium more luxuriant. After one hour in the culture medium the spores began to show signs of germination. The germ-cell loses its colour, and becomes spherical and swollen, increasing to about 8 to 9 μ in diameter. In a culture four hours old, the majority of the spores had germinated. The germ-cell of some spores had swollen to a diameter of nearly 10 μ, and had produced generally one germ tube, but sometimes two, one on each side of the germ-cell, non-septate, and varying in length from 3 to 15 μ and in diameter from 2 to 4 μ. In a

culture twenty-four hours old the germ tubes were of varying length, much branched and septate, varying in diameter up to 6 μ. (Plate X, figs. 7-10). Very often each spore possessed two germ tubes, one on each side of the germ-cell. The time taken, therefore, for a spore to germinate in nutrient solution is about four hours.

Spores were grown in pure culture in Maize-meal agar, French-bean agar, and Quaker oat agar. Details of growth on the media are given below:

Oat agar. The culture tubes were inoculated with spores from a Maize-meal culture. On the fourth day the hyphae have grown 3·5 cms. from the point of inoculation and show zoning, the rings of hyphae forming the denser parts of the zones, being a little less than 1 cm. apart. With progress in growth the hyphae unite into small masses to form white tufts; these tufts are scattered all over in abundance, but are chiefly present at the denser parts of the zones. On the seventh day the mycelial growth becomes pink while the medium turns salmon-pink. On the eighth day a black mass of spores begins to be extruded from the centre of each tuft, and on the tenth day the hyphae have overrun the whole surface of the medium which is studded all over with these small black masses. The salmon pink colour of the medium begins to fade when the culture is eleven days old and fades completely with age. When the culture is old the mycelial growth on the surface of the medium is hardly visible owing to the abundant formation of the small black pustules of spores. Hyphae grow up the sides of the tube for a distance of about 5 mm.

Microscopic examination. Single masses of spores, when picked out with a needle, come off very easily and appear to be situated superficially on the loose hyphae growing on the medium. When pressed under a cover glass and examined, the spores are seen to arise in a mass of pseudo-parenchymatous cells faintly yellowish in colour. In microtome sections these pseudo-parenchymatous bodies are found to be distinct pycnidia. Pycnidia are present in large numbers on the loose mycelium growing on the medium and are of diverse shapes and sizes, globose, rectangular, spherical, rectangular oval, laterally oval, etc. They occur singly, or in groups very often having common walls. The pycnidia are completely closed by a pseudo-parenchymatous wall, which may be of uniform thickness or may vary in thickness in a single pycnidium. Spores are borne on the wall and liberated by a rupture of the wall anywhere. A definite stroma composed of interwoven hyphae is found in the culture medium, varying in depth from 0·22 mm. to

0·26 mm. A few spherical pycnidia are embedded in this stroma partly or completely, (Plate VI, fig. 5), and their spores are liberated by a rupture of the wall at the top or sides to the exterior, or at the base into the stroma or culture medium. The following examples are cited:

(*a*) *Pycnidia in the loose mycelium on the culture medium.* (1) Spherical, diameter 85 μ; wall 18 μ thick. (2) Globose, width 70 μ, height 50 μ, wall 6–10 μ thick. (3) Rectangular oval, width 120 μ, height 70 μ, wall 5–15 μ thick. (4) Globose, width 240 μ, height 180 μ, wall 20 μ thick; spores liberated by a rupture of the wall at the top. (5) Laterally oval, width 130 μ, height 70 μ, wall 6 μ thick; spores liberated by a rupture of the wall at the side. (6) Spherical, diameter 100 μ, wall 8 μ thick.

(*b*) *Pycnidia in the stroma formed in the medium.* (1) Spherical, solitary, embedded in the stroma, surface of stroma slightly raised owing to presence of the pycnidium; internal diameter 140 μ; wall 20 μ thick; spores liberated to the exterior by a rupture of the wall at the side. (2) Spherical, and similar to the above but with a diameter of 160 μ; spores liberated by a rupture of the wall at the side into the stroma, into an almost spherical cavity about 100 μ diameter which is filled by the spores.

Spores. The length including the terminal hyaline cells was 15–23 μ, mean 18·8 μ; the coloured cells, 10–15 μ, mean 12 μ; width 5–7 μ, mean 5·5 μ; pedicel when present 1–5 μ in length, very often not present; cilia 1–2 in number, rarely three, short, and generally up to about 5 μ in length, rarely reaching 10–12 μ, apex of cilia not knobbed. Attempts were made to cause the cilia to knob by growing spores from culture on tea and coconut leaves sterilised by boiling in Roux tubes, but without success. The comparatively young hyphae were thin, sparingly branched and non-septate. At a later stage septa are formed and in old cultures they are very frequent. The hyphae were not generally constricted at the septa, though distinct constrictions were seen in some hyphae. The hyphae which appeared pink in mass were hyaline when mounted in water and examined under the microscope. The diameter of the hyphae was up to 3 μ. Some hyphae were profusely branched and irregularly swollen, the width at the swellings reaching nearly 7 μ. Some old hyphae were full of fat globules.

French-bean agar. The agar slants were inoculated with spores from a pure culture. On the fourth day the hyphae have grown a distance

of 2 cms. and have collected at irregular intervals into small white masses presenting the appearance of tufts. On the fifth day zoning is evident and the culture medium begins to assume a brownish-orange colour. On the sixth day the mycelial growth presents a faint pinkish tinge; tufts of white or pinkish hyphae are scattered all over and from the centre of each tuft a small black mass of spores is extruded. The intervening spaces between the tufts are covered with hyphae matted together to form a film of mycelium on the medium, sprinkled all over in abundance with these tufts of hyphae. By the eleventh day all the tufts have produced black masses of spores, and the film of mycelium is covered all over by countless numbers of these small black masses, the tufts themselves not now being visible. Very fine and scattered hyphae ascend the sides of the tube for a few millimetres.

Microscopic examination. Single masses of spores were picked out with a needle and examined. The spores are extruded from pycnidia. The pycnidia are spherical, flask-shaped, or globose, brownish-yellow in colour, thin-walled, completely closed and lacking an ostiolum, single or aggregated, slightly embedded in the culture medium, or borne on the film of mycelium on the medium. The diameter of the pycnidia varies from 100 to 250 μ. The spores are liberated by a rupture of the neck in the flask-shaped pycnidia or by a rupture at the top in the others. In one instance, when a single flask-shaped pycnidium was being examined, spores were seen being liberated in quick succession through a vertical split at the apex. Many spores had the lowest coloured cell swollen and light in colour, indicating that the preliminary stages of germination had begun inside the pycnidium. A comparison of the size of the pustule of spores extruded from a single pycnidium with the size of the pycnidium itself leads to the supposition that spores are formed in rapid succession within the pycnidium.

Further examination was made by embedding pieces of the culture medium and microtoming. In microtome sections all the black masses of spores are found to be liberated from pycnidia. A definite stroma composed of interwoven hyphae is formed in the culture medium. In some parts this stroma is 10–20 μ deep and in other parts 20–50 μ deep. Pycnidia are present in large numbers in the loose mycelium on the surface of the medium (Plate VI, fig. 1), and very few in the thin stroma in the culture medium. The shape of the pycnidia varies. They are spherical, globose, flask-shaped, oval, depressed globose with a conical apex, globose with a conical apex, rectangular oval. They are completely enclosed by a pseudo-parenchymatous wall which may be of uniform thickness or may vary in thickness in a single pycnidium. Spores

are borne from a layer of cells on the wall and are liberated by a rupture of the wall at any place. The pycnidia occur singly or in groups; two, one large and the other very small joined together by a common wall is of frequent occurrence (Plate VI, fig. 3); those which occur in groups may have either distinct walls or common walls. The following are examples of the pycnidia: (1) Spherical, diameter 60 μ, wall 10 μ thick. (2) Flask-shaped, greatest height 100 μ, greatest width 60 μ, wall 5 μ thick. (Plate VI, fig. 2). (3) Globose, diameter 80 μ, wall 4 μ thick. (4) Rectangular, width 160 μ, height 100 μ, wall 5–10 μ thick. (5) Laterally oval, width 160 μ, height 80 μ, wall 15 μ thick. (6) Globose, width 110 μ, height 80 μ, wall 10 μ thick. (7) Rectangular oval, width 240 μ, height 160 μ, wall 18–20 μ thick. (8) Laterally oval, width 0·26 mm. height 0·09 mm., wall 15 μ thick.

Spores. The length including the terminal hyaline cells was 15–22 μ, mean 18·7 μ; the coloured cells, 10–15 μ, mean 12 μ; width 5–6 μ, mean 5·4 μ; pedicel, generally absent, when present 1–3 μ long; cilia 1–2 in number, very rarely three, short and generally up to about 5 μ in length, rarely reaching a length of 10 μ; apex of cilia not knobbed; when spores were grown on sterilised tea and coconut leaves, the apex of the cilia underwent no change. The hyphae were hyaline, septate, branched, and had a general diameter up to about 3 μ. One abnormal spore with five coloured cells was seen in culture; the whole spore measured 25×6 μ; the coloured cells 20×6 μ; it had one cilium 5 μ long, and no pedicel.

Maize-meal agar. The agar slants were inoculated with spores from a pure culture. From the point of inoculation the hyphae run along the surface of the medium for about 1 cm. and stand out aerially more or less presenting the appearance of tufts. The fungus grows scantily and forms tufts again at a distance of about 1 cm. from the original tufts. A faint zoning is seen, but it is not well defined. The fungus then forms tufts irregularly all over the medium and as the culture becomes older a black speck arises in the centre of each of these white tufts, the black speck being a mass of spores. Spore formation begins on the seventh day, and by the tenth to twelfth day the whole surface of the medium is studded with these small black pustules of spores. At the edge of the tube where the culture meets the glass, a thin, scanty, growth of hyphae is seen to ascend the sides of the tube for a few millimetres. With advancing growth the medium acquires a cream colour.

Microscopic examination. In microtome sections the pustules of spores are seen to be liberated from pycnidia. The pycnidia occur in large numbers on the loose mycelium growing on the medium. No

definite stroma is formed in the medium but instead there is a loose network of hyphae, 0·52 to 0·65 mm. deep, the network gradually becoming scanty deeper in the medium. A few pycnidia are embedded in this network or pseudo-stroma, either partly or completely, and very few embedded in the culture medium itself. The pycnidia found in the loose mycelium on the surface are of various shapes and sizes; they are spherical, laterally oval, flask-shaped, cone-shaped, globose, sphaeroidal, rectangular, square with rounded corners, etc., and occur singly or in groups. A large pycnidium joined to a very small one, with a common wall, is of frequent occurrence; and sometimes two spherical pycnidia of practically the same dimensions are united laterally by a common wall. The pycnidia which are embedded in the pseudo-stroma are sphaeroidal in shape, while those embedded in the culture medium are oval. In every case the pycnidium is enclosed by a pseudo-parenchymatous wall, which may be of uniform thickness or may vary in thickness in the same pycnidium. Spores are borne from the sides of the wall and liberated by a rupture of the wall at any point. The pycnidia embedded in the culture medium liberate spores into a cavity in the culture medium itself. The following are examples of the pycnidia:

(*a*) *Pycnidia in the loose mycelium on the medium.* (1) Spherical, diameter, 110 μ, wall 10 μ thick. (2) Flask-shaped, height 180 μ, width 130 μ, wall 10 μ thick. (3) Laterally oval, width 0·26 mm., height 0·15 mm., wall 15 to 20 μ thick. (4) Cone-shaped, height 100 μ, width 85 μ, wall 8 μ thick. (5) Globose, width 55 μ, height 45 μ, wall 2–3 μ thick.

(*b*) *Pycnidium in the pseudo-stroma.* Sphaeroidal, partly embedded, diameter 160 μ, wall 18 μ thick.

(*c*) *Pycnidium embedded in the culture medium.* Oval, width 120 μ, height 60 μ, wall 15–20 μ thick, spores liberated by a rupture of the wall and filling a cavity in the medium at the side of the pycnidium.

Spores. The length including the terminal hyaline cells was 15–23 μ, mean 18·5 μ; the coloured cells, 10–15 μ, mean 12 μ; width 5–7 μ, mean 5·7 μ; pedicel not present in a large number of spores, when present 1–3 μ long; cilia 1–2 in number, very rarely three, short, generally up to about 5 μ long, rarely reaching 10 or 12 μ; apex of cilia not knobbed. The hyphae were hyaline, septate, branched, usually between 2–3 μ in diameter. Some hyphae were irregularly swollen and reached a diameter of about 5 μ at the swellings. Old hyphae are distinctly constricted at the septa, particularly when a branch arises near the septum.

Below is a table giving the dimensions of the spores in nature and on the various culture media:—

Media.	Range of length including terminal hyaline cells.	Mean length.	Range of length of coloured cells.	Mean length.	Range in width.	Mean width.
Leaves in nature.	15–25 μ	20·2 μ	12–16 μ	13·8 μ	5–7 μ	5·7 μ
French-bean agar.	15–22 μ	18·7 μ	10–15 μ	12·0 μ	5–6 μ	5·4 μ
Oat agar.	15–23 μ	18·8 μ	10–15 μ	12·0 μ	5–7 μ	5·5 μ
Maize-meal agar.	15–23 μ	18·5 μ	10–15 μ	12·0 μ	5–7 μ	5·7 μ

The chief feature of growth in all these three media is the accumulation of hyphae to form tufts. These tufts are originally white in colour and later assume a pinkish tinge. As the fungus advances in age, black pustules of spores are seen to arise from the centre of each of these tufts. In old cultures, the white mycelial growth on the medium was covered with these little black pustules in abundance. In the French-bean and Oat media a stroma is formed in the culture medium, while in the Maize-meal instead of a stroma a loose net-work of hyphae or a pseudo-stroma is present.

In all the three media, spores that appear to be in pustules are found to originate in distinct pycnidia. Pycnidia are present in large numbers on the loose mycelium growing on the medium and are of diverse shapes and sizes. They are spherical, laterally oval, flask-shaped, rectangular, sphaeroidal, globose, oval, rectangular-oval, cone-shaped, etc. They consist of a pseudo-parenchymatous wall, yellowish in colour, not possessing an ostiolum, and occur singly, or in groups very often having common walls. Spores are liberated by a rupture of the wall at any point. A few spherical or sphaeroidal pycnidia are embedded, partly or completely in the stroma formed in the French-bean and Oat agar, and in the pseudo-stroma in the Maize-meal agar. Spores were seen liberated from these by a rupture of the wall to the exterior,

or into the stroma or culture medium. In the Maize-meal agar, a few pycnidia are embedded in the culture medium, liberating spores by a break in the wall into the culture medium.

In all the media the cilia are very short, vary in number from 1 to 3 and are not knobbed. They are usually between 2 to 5 μ in length, rarely reaching 10 to 12 μ. In some spores the pedicel is not present; when present it is generally between 1 and 3 μ long, rarely attaining 4 to 5 μ in length. Attempts were made to cause the cilia to knob by growing the fungus on tea and coconut leaves, sterilized by boiling, in Roux tubes, but no success was attained. A peculiarity about this *Pestalozzia* is that the cilia are shorter in culture than in nature, and than although the cilia are knobbed in nature they are never knobbed in culture.

The base of a coconut petiole suspected to be attacked by *Phytophthora* was incubated, and pustules of *Pestalozzia* spores were hatched out corresponding in dimensions with the spores in culture, all possessing short cilia and not knobbed. The spores behaved in the various culture media in the same manner as those obtained from the leaf.

INOCULATIONS

(A) On coconut.

(1) Coconut leaflets were cut into lengths of about 5 inches, washed in 0·1 per cent corrosive sublimate, then in distilled water and placed in a moist chamber. The inocula used were small pieces of Maize-meal agar culture. 9 inoculations were made on the upper surface of the leaf, 9 inoculations on the lower surface and 9 by wounding the leaf with pin pricks. The 18 inoculations made without wounding were failures. The 9 wounded inoculations were all successful. Typical grey blight patches were formed and fructifications were noticed a month after inoculation. The control was free.

(2) 4 inoculations were made on the under surface of the leaf in the same manner as the above, but in this case the inoculum was enclosed in a circular ring of soft paraffin. Two inoculations were successful. Discolouration of the tissue began on the fourth day and the patch gradually increased in size. The other two inoculations failed to take. The control was free.

(3) Coconut seedlings about 3 ft. high were selected for this experiment. The leaves were first washed in 0·1 per cent corrosive sublimate and then in distilled water prior to inoculation. The inocula used were small pieces of Maize-meal agar culture. 4 inoculations were made on the lower surface of the leaf without wounding, and 5 inoculations by wounding, the wounds being caused by gently scraping

the epidermis of the under surface lengthwise and crosswise so as to occupy an area of about 4 mm. × 5 mm. The inoculated leaves were enclosed in large gas cylinders supported on heavy tripods and the open end plugged with cotton wool. On the third day after inoculation signs were evident of infection on the wounded areas. The original wounded area formed a greyish patch on the upper surface with a translucent band outside it, shading into the green. With the further progress of the disease the spot presented the following appearance. Round the gray patch a reddish-brown margin about 0·5 mm. wide was formed and then a translucent band, about 1·5 mm. wide, bounded on the outside by another reddish-brown ring about 0·2 mm. wide. Outside this ring is another translucent band 0·5 mm. wide shading into the green. Black pustules of spores appeared on the gray patch 6 days after inoculation. All the wounded inoculations behaved practically in a similar manner. The unwounded inoculations failed to take. The control was free.

40 inoculations were made in all, 14 by wounding, 17 on the unwounded lower surface of the leaf, and 9 on the unwounded upper surface. All the wounded inoculations were successful. Of the 26 unwounded inoculations only 2 were successful.

(B) On tea.

(1) Full-grown leaves were washed in sterile water and inoculated with pieces of the culture medium bearing spores and hyphae. Prior to inoculation the leaves were wounded by shaving off a small area of the epidermis with a razor. 11 inoculations were made on the upper surface and 11 on the lower surface. The leaves were left in a moist chamber for 21 days, but none of the inoculations took effect. The control was free.

(2) Old and hard leaves on a bush in the open were washed in distilled water wounded by shaving off a small area of the epidermis of the upper surface of the leaf and inoculated with spores and hyphae from a pure culture. The leaves were enclosed in a large glass tube, the open end of which was plugged with cotton wool. 4 inoculations were made. 4 inoculations were made on the lower surface of full-grown leaves in a similar manner to the above, but without wounding; and 3 inoculations on the upper surface and 3 on the lower surface of tender leaves. All the 14 inoculations were unsuccessful. The control was free.

(3) Young tea plants about 7 inches high, were planted in a pot and covered with a bell glass. Leaves were washed in distilled water, wounded by pricking through and through with a sterilised needle, and the wounds inoculated on the top surface with pieces of Maize-meal agar culture. The culture was kept moist by frequent wetting with

distilled water. 6 inoculations were made, but although the inoculum remained on the surface for a fortnight no penetration took place. The control was free.

32 inoculations were made after wounding, 21 on the upper surface and 11 on the lower surface and 10 without wounding, 3 on the upper surface and 7 on the lower surface. All were unsuccessful.

COMPARISON OF THE TWO SPECIES

The spores of the species on tea are, on the average, larger than those of the species on coconut. The mean dimensions of the spores in nature and on the culture media employed are as follows:—

	Length including terminal hyaline cells.	Length of coloured part.	Breadth.
Tea sp. in nature.	25·6 μ	18·0 μ	6·7 μ
Tea sp. in culture.	27·0 μ	18·3 μ	6·8 μ
Coconut sp. in nature.	20·2 μ	13·8 μ	5·7 μ
Coconut sp. in culture.	18·6 μ	12·0 μ	5·5 μ

The species on tea, in culture, produces a rich fluffy growth of aerial hyphae which eventually form a compact, dense, white felt overlying the medium, whereas the species on coconut forms tufts of hyphae.

In the case of the tea *Pestalozzia* spores are borne in large numbers on the loose hyphae, but the coconut *Pestalozzia* does not produce any spores on free hyphae.

The tea *Pestalozzia* produced fewer pycnidia in culture than the coconut *Pestalozzia*, but the pustules of spores extruded from the pycnidia of the former were larger than those extruded from the pycnidia of the latter.

In the case of the tea *Pestalozzia*, pycnidia and pseudo-parenchymatous stromata were formed chiefly in the stroma in the culture medium, while in the coconut *Pestalozzia* cultures pycnidia were produced in abundance in the loose mycelium on the medium, and only very few in the stroma in the culture medium.

The cilia of the spores of the tea *Pestalozzia* are knobbed in nature. In culture, some spores have cilia which are not knobbed, but if these spores are sown on tea or coconut leaf sterilized by boiling in Roux tubes, they readily produce spores with knobbed cilia. The spores of the coconut *Pestalozzia* also have knobbed cilia in nature, but those produced in

culture had cilia without knobbed tips, and these did not revert to the knobbed form when sown on sterilized tea or coconut leaf.

The cilia of the tea *Pestalozzia* became very long in culture attaining lengths up to 45 μ, whereas the cilia of the coconut *Pestalozzia* remained comparatively short, up to about 12 μ.

These differences appear to be sufficient to maintain the two species distinct.

The species on tea with very minute differences agrees with that described by Sawada in Formosa in 1915. This Ceylon species is therefore *Pestalozzia Theae* Sawada.

Cooke described *P. palmarum* from a dead sprout of a germinating coconut from Bengal. An examination of the type showed that the dimensions of the spores are identical with those of the Ceylon species; Cooke's published description in Grevillea, Vol. IV, p. 114, does not agree with the actual spore dimensions of his specimen. There is no doubt that the Ceylon species on the coconut leaf is *Pestalozzia palmarum* Cke.

A VARIANT STRAIN ON TEA

When spores of *Pestalozzia Theae* were isolated and transferred to Maize-meal agar slants, the mycelial growth in one tube differed considerably from the rest in not being fluffy and not so luxuriant as the others. This tube was separated from the rest and kept under observation. On the ninth day spores began to be formed in pustules, and these, when examined microscopically, were found to differ considerably from *P. Theae* in the size of the spore, its width, the formation of the cilia, and the absence of a knob at their apices (Plate IX, figs. 2,4,5). Subcultures were taken from these. The chief characteristics of this spore are the peculiar swelling at the junction where the cilia originate, as shown on the drawings, and the branching of the cilia. The number of cilia varies from 3 to 6 on different substrata, and one, two, or even three may be branched.

A large number of diseased leaves attacked by grey blight from different localities were examined to ascertain whether this type of spore occurs in nature, but none was found. Single spores were again isolated from different patches and grown in culture, to find out whether this kind of spore would occur again in cultures; but this too was a failure, the spores in culture behaving normally. The variant spores were also grown on tea and coconut leaves sterilised by boiling in Roux tubes, and in both cases they underwent no change.

On sterilised coconut leaf the dimensions of the spores were 25–35 × 7–10 μ; the length of coloured cells was 16–22 μ; the cilia were up to 40 μ in length, and 2 to 6 in number; no pedicel was present. One abnormal spore with 5 coloured cells was seen, the whole spore measuring 36 × 9 μ and the coloured cells 29 × 9 μ; four cilia were present, up to 20 μ long (Plate IX, fig. 3.). On sterilised tea leaf the spores were, on the average, longer, varying in length from 28 to 42 μ and in width from 7 to 9 μ; the length of the coloured cells was 18–29 μ; no pedicel was present; the cilia were 3 to 6 in number and up to 30 μ long. As care had been taken to examine the pustule from which the spores were plated and isolated in order to make sure that the pustule bore spores of the normal kind, it would appear that this spore originated from a typical spore of *Pestalozzia Theae* and is a variant of that fungus.

CULTURES

Spore Germination. A series of hanging drop cultures were made in distilled water and standard nutrient solution. *In distilled water* the spores did not appear to thrive, the percentage of germinating spores being very low. In a culture five hours old the majority of the spores had undergone no change. Only a few had germinated, sending out germ tubes, 20 to 50 μ long and 3 to 3·5 μ diameter, from the lowest of the three coloured cells. One spore had germinated from the uppermost coloured cell. In a culture six hours old one spore had germinated from the second coloured cell and another from the uppermost coloured cell. In a culture twenty-six hours old, two spores had germinated from the apical hyaline cell. In a culture forty-eight hours old one spore which had only four cells had germinated from the side of the apical hyaline cell; another normal spore had formed a small spherical swelling on the top of the apical hyaline cell and from this two germ tubes had grown, one at the top and another at the side. The majority of spores did not germinate in water, although the culture was left for four days. It will thus be seen that water is unfavourable as a medium for spore germination in this case, and when germination does occur it is irregular. *In nutrient solution* germination was good (Plate IX, figs. 6, 7). In a culture two hours old the lowest of the three coloured cells in a large number of spores was losing its colour and becoming spherical. In a culture five hours old this spherical cell had swollen up to about 10 μ in diameter, and in a few spores small germ tubes had protruded from the sides. In a culture six hours old a large number of spores had germinated from this particular cell which had become colourless and had produced either one or two germ tubes, varying in length up to 70 μ and in diameter from 2·5 to 6 μ, much branched and

septate. Spores with three germ tubes from the same cell were occasionally present. In a culture twenty-four hours old some spores were just beginning to germinate. It will thus be seen that spore germination in nutrient solution takes place from the lowest of the three coloured cells, and the time taken for a spore to germinate is usually about five hours, though some may take as long as twenty-four hours.

Spores were grown in pure culture on Maize-meal agar, Oat-agar and French-bean agar. Details of growth on these media are given below.

Oat agar. The slants were inoculated with spores from a pure culture. On the third day hyphae radiate from the point of inoculation for a distance of about 1 cm. and are confined to the surface of the medium. The hyphae now run over the surface of the medium in an irregular fashion, the advancing hyphae showing a branching appearance. A slight zoning is evident, but hardly perceptible. On the fifth day hyphae collect here and there into small white masses, scattered all over the surface of the medium. On the sixth day the medium begins to assume a salmon-pink colour. On the seventh day the small white masses of hyphae turn greyish in colour and finally black, owing to the appearance of spores in the centre in pustule form. The growth is now slow, and with age the whole surface of the medium is studded irregularly with black pustules. Hyphae ascend the sides of the tube in thin irregular strands for about 3 mm. and form pustules of spores on the glass. On the thirteenth day the mycelial growth is pinkish in colour, and the medium salmon-pink chiefly at the edges. As the culture ages these colours vanish. No aerial growth of mycelium occurs at any time.

Microscopic examination. In microtome sections, a definite stroma is present in the medium to a depth of 0·26–0·52 mm. Pycnidia of various shapes and sizes, up to 1 mm. diameter, are situated on the stroma, or partly embedded in the stroma (Plate VII, figs. 5, 6, 7) completely closed by a pseudo-parenchymatous wall (Plate VII, fig. 4), which may vary in width in the same pycnidium. Spores are generally borne from all sides of the wall and liberated by a rupture of the wall anywhere. In one pycnidium the width of the wall varied from 20 to 80 μ, and spores were borne in this pycnidium from all sides of the wall except at the base. In another pycnidium, globose in shape, 0·29 mm. high, partly embedded in the stroma, spores were borne from all sides of the wall, the thickness of the wall varying from 20 to 30 μ. Some pycnidia liberate their spores into the stroma (Plate VII, fig. 5) or the culture medium. One was seen, globose in shape, 0·32 mm wide and 0·19 mm.

high, partly embedded in the stroma, which had liberated its spores at the base through an orifice 60 μ wide, opening into the stroma, where they occupied a cavity, oval in shape 0·22 mm. long and 0·16 mm. diameter. Many pycnidia were small and spherical, about 0·13 mm. in diameter; in these the spores were borne over the whole of the inner surface.

Spores. The length of the spore, including the terminal hyaline cells, was 25–35 μ, mean 29·2 μ; the coloured cells 17–23 μ, mean 19·4 μ; width 6–10 μ, mean 7·8 μ; pedicel not present; cilia 3 to 5 in number, and up to 30 μ long, generally three and branched. Abnormal spores having only one coloured cell or sometimes two coloured cells occasionally occur in culture. Many spores with unbranched cilia occur, but these possess the characteristic swelling at the point where the cilia originate. The cilia are not knobbed but rounded off at the apex.

The young hyphae are slender, sparingly branched and sparingly septate; in older stages the septa are common and when still older the septa are formed at frequent intervals. The larger hyphae, about 4 μ in diameter, are branched, constricted at the septa, and frequently filled with fat globules. Irregularly swollen hyphae are also present, up to about 6 μ diameter at the swellings. The hyphae which penetrate deeply into the culture medium are long, sparingly branched, closely septate and up to 3 μ in diameter.

French bean agar. French bean tubes were inoculated with spores from a pure culture. On the fourth day hyphae have grown 2 cms. and radiate in strands from the centre. From the fifth day onwards the advancing margin consists of hyphae radiating in strands. On the seventh day hyphae collect here and there into small white masses. From the eighth day onwards black pustules of spores are produced from the centre of each of these small masses, and by the fifteenth day all the white masses of hyphae have formed black pustules. Growth is confined entirely to the surface and interior of the medium with no aerial growth whatever. A faint zoning could be seen, but it was very slight.

Microscopic examination. The small white masses of hyphae just beginning to liberate spores in pustule form were picked out with a needle and examined under a dissecting microscope. They were found to contain globose or rounded bodies up to 2 mm. in diameter, single or aggregated, yellowish or reddish brown in colour. When torn with a needle the top half separates easily, leaving the lower portion as a cup, black inside owing to the mass of spores. In microtome sections

these globose or rounded bodies are seen to be pseudo-parenchymatous stromata containing pycnidial cavities (Plate V, fig. 1). A definite stroma composed of interwoven hyphae is formed in the culture medium, varying in depth from 0·22 mm. to 0·46 mm. The stromatic bodies are formed on this stroma. They are frequently irregularly lobed, and may contain one or several cavities. The whole body is covered when young with a weft of mycelium forming a thin compact felt,—a continuation of the felt of mycelium on the culture medium. The thickness of the stromatic tissue round the pycnidial cavities varies. In one stromatic body, which had a width of nearly 2 mm. and had three pycnidial cavities, the diameter of the cavities varied from 0·20 mm. to 1·17 mm. Spores are borne from a layer of cells on the pycnidial wall and are liberated by a rupture of the wall at any point, either at the top, or the sides, or at the base into the stroma or culture medium.

Spores. The length, including the terminal hyaline cells, was 24–36 μ, mean 30·3 μ; the coloured cells 16–25 μ, mean 19·8 μ; breadth 6–10 μ, mean 7·2 μ; pedicel not present; cilia 3 to 6 in number and up to 40 μ long. One abnormal spore measured 42 × 6 μ, with the coloured cells 30 × 6 μ; it had 5 cilia up to 18 μ long.

The hyphae were hyaline, septate, branched, and generally up to 3 μ in diameter. Irregularly swollen hyphae were present with a diameter at the swellings up to 8 μ.

Maize-meal agar. The slants were inoculated with spores from a pure culture. The mycelial growth is confined to the surface and interior of the medium, and by the fifth day it has extended 2·5 cm., and exhibits zoning. On the seventh day hyphae collect into small white masses at irregular intervals; and from the ninth day onwards these small white masses begin to produce spores in pustule form. With advancing growth the medium changes to a cream colour, and the whole surface becomes studded irregularly with black pustules of spores; in some tubes which show distinct zoning the pustules are more numerous at the denser bands, especially when the culture is old. No aerial growth is seen, and the hyphae ascend the sides of the tube for about 2 mm. only.

Microscopic examination. Under a dissecting microscope the black pustules are seen to arise from a body in the felt of mycelium on the medium. A pustule arises from each body in the form of a cone with a short thin stalk. The body is light brown in colour or mottled brownish and white, the mottling being caused by the white scattered hyphae of the thin felted layer which overlies the light brown wall. When young these bodies appear as small, pale yellowish protuberances

situated on the medium, elevating the thin web of mycelium which covers it. When older the web of mycelium is ruptured and the body appears quite prominent, globose or rounded.

In microtome sections, a definite stroma composed of interwoven hyphae is found in the medium in some tubes, varying in depth from 0·39 mm. to 0·61 mm., while in others there is no stroma but a loose network of hyphae, or pseudo-stroma, varying in depth from 0·26 mm. to 0·29 mm. The bodies from which the spores are extruded are all pycnidia, globose or spherical in shape, situated on the stroma or pseudo-stroma, or partly or completely embedded in the stroma or pseudo-stroma, or embedded in the culture medium (Plate VII, fig. 2). The pycnidia are completely enclosed by a pseudo-parenchymatous wall, which bears spores over all the interior surface, the spores being liberated by a break in the wall at the top or sides to the exterior, or at the base into the stroma or culture medium. The thickness of the wall may be constant in the one pycnidium or it may vary. In one pycnidium the thickness varied from 40 to 120 μ and in another from 10 to 20 μ. Below are examples of the pycnidia:

(*a*) *Pycnidium almost superficial, or partly embedded in the stroma.* Globose, 0·59 mm. wide and 0·42 mm. high, covered with a thin web of mycelium, wall varying in thickness from 40 to 120 μ; spores liberated at the base by an opening of the wall, 120 μ wide, into the stroma, filling an oval cavity 0·48 mm. wide and 0·39 mm. long.

(*b*) *Pycnidium completely embedded in the stroma.* Spherical, 0·33 mm. diameter, wall 20 to 40 μ thick.

(*c*) *Pycnidia embedded in the culture medium.* (1) Spherical, diameter 200 μ, wall 10 to 20 μ thick; spores liberated into the culture medium and filling a cavity about the same size as the pycnidium. (2) Spherical, diameter 180 μ, wall 15 to 20 μ thick; spores liberated by a split in the wall and filling a cavity in the medium, oval in shape, 0·39 mm. long and 0·26 mm. wide.

Spores. The length, including the terminal hyaline cells, was 25–32 μ, mean 28·9 μ; the coloured cells 18–22 μ, mean 19·5 μ; width 6–10 μ, mean 8·6 μ; pedicel not present; cilia 3 to 5 in number and up to 32 μ long. Many abnormal spores were present in culture, some having only one (Plate VII, fig. 1) and others only two coloured cells.

The hyphae were hyaline, septate, branched and generally up to 3 μ in diameter; irregularly swollen hyphae were also present with a diameter at the swellings up to about 5 μ.

The following table gives the dimensions of the spores on the various culture media.—

Media.	Range of length including terminal hyaline cells.	Mean length.	Range of length of coloured cells.	Mean length.	Range in width.	Mean width.
Oat agar.	25–35 μ	29·2 μ	17–23 μ	19·4 μ	6–10 μ	7·8 μ
French-bean agar.	24–36 μ	30·3 μ	16–25 μ	19·8 μ	6–10 μ	7·2 μ
Maize-meal agar.	25–32 μ	28·9 μ	18–22 μ	19·5 μ	6–10 μ	8·6 μ

The vegetative growth of this strain on the media stated differs entirely from that of *P. Theae* by the absence of the rich fluffy growth of aerial hyphae which occurs in cultures of the latter species and by the absence of the formation of spores on loose hyphae. In the different culture media the number of cilia varied from 3 to 6, while their length was up to 40 μ; they were frequently branched and the apices were not knobbed. As a rule, no pedicel was visible, and when present it was so short as to be almost imperceptible.

INOCULATIONS

Inoculations were made on detached tea leaves in a moist chamber and on leaves on the plant.

(1) 10 inoculations were made on detached tea leaves in a moist chamber with small pieces of Maize-meal agar culture; the leaves were washed in distilled water, wounded by shaving off a small area of the epidermis with a razor and the inoculum placed on the wounds. 9 inoculations failed and one was successful.

(2) This experiment was similar to the previous one but the inocula used were spores mixed with a few drops of nutrient solution. Four inoculations were tried and all were successful. In the inoculations regarded as successful in this series, the fungus attacked the wounded area and produced fructifications, but it did not extend into the surrounding tissue.

(3) With the same inoculum as No. 2, 6 inoculations were made on the upper surface and 6 on the lower surface of leaves without wounding, but all failed to take.

(4) Leaves of a bush in the open, were first washed in 0·1 per cent corrosive sublimate, then in distilled water, wounded by scraping the epidermis of the upper surface of the leaf with a needle and inoculated with small pieces of culture medium bearing spores. The leaf was enclosed in a large tube, the open end of which was plugged with cotton wool. 5 inoculations were made and all were successful.

(5) 4 inoculations were made on the lower surface, 2 on the upper surface and 3 on petioles, in a similar manner, but without wounding. All were failures.

(6) Young tea plants, about 6 to 7 inches high, were planted in a pot and covered with a bell glass. 8 inoculations were made on the upper surface and 4 on the lower surface of the leaves. Spores were germinated in hanging drops of nutrient solution and when the culture was 6 hours old and the spores had germinated the cover glass with the culture was placed on the leaf. All the inoculations were failures. 6 more inoculations were made on the upper and lower surfaces using pieces of Maize-meal agar culture and these too were failures.

58 inoculations were made in all,—17 on the unwounded lower surface of the leaf, 19 on the unwounded upper surface, 19 on the leaf after wounding and 3 on the petioles. The inoculations on the uninjured lower and upper surfaces of the leaf were all unsuccessful, while out of the 19 inoculations on the wounds, 10 were successful; those on the petioles were all failures.

A VARIANT STRAIN ON COCONUT

When diseased patches were being examined in the course of obtaining material for single spore cultures, a few pustules were found to contain spores which had no knobs at the apices of the cilia. These individual pustules were carefully examined to ascertain whether spores with knobbed cilia were present, but none were observed. The majority of pustules on the patch had spores with knobbed cilia, and these were examined to ascertain whether the unknobbed form occurred in them, mixed with the normal spores. So far as could be determined by microscopic examination, spores with knobbed cilia and spores with unknobbed cilia were in different pustules.

An examination of spores with unknobbed cilia gave the following results: the whole spore, including the terminal hyaline cells, measured 17–25 μ in length, mean 20·7 μ; the coloured cells 11–17 μ, mean 13·7 μ; width 5–8 μ, mean 6·4 μ; cilia not knobbed, 2 to 4 in number, usually 3, up to 40 μ long; pedicel 3 to 10 μ long. Normal spores of *Pestalozzia palmarum* gave the following dimensions: the whole spore, including the terminal hyaline cells, measured 15–25 μ in length, mean 20·2 μ;

the coloured cells 12–16 μ, mean 13·8; width 5–7 μ, mean 5·7 μ; cilia knobbed, generally about 20 μ long, occasionally attaining a length of 40 μ. The main difference between this spore and that of *P. palmarum* is that the cilia are long and not knobbed. Single spores were isolated and grown in pure culture in Maize-meal agar, Quaker Oat agar and French-bean agar.

CULTURES

Spore germination. Spores were sown in hanging drops of distilled water and standard nutrient solution. In both media the spores germinated from the lowest of the three coloured cells. *In distilled water*, in a culture four hours old the germ-cell in a few spores was losing its colour, and becoming spherical; a few spores had produced germ tubes 10 to 20 μ long and 3 to 3·5 μ wide. In a culture five hours old the majority of the spores had germinated, the germ tubes being up to 50 μ long. In a culture twenty-four hours old the spores had germinated with very few exceptions, and in those which had not germinated the germ-cell was colourless and swollen; in the majority of cases only one germ tube was produced, but many spores had two germ tubes, one on each side of the germ-cell. Very often a germ tube branched at the base (Plate X, fig. 1). The germ tubes were very long and septate, generally up to 3·5 μ wide, rarely reaching a width of 4 μ. *In nutrient solution*, the germ-cell begins to lose its colour when the culture is one hour old. In many cases a light band is seen across the germ-cell. In a culture four hours old, short germ tubes are present, 5 to 10 μ long. In a culture five hours old practically all the spores had germinated and possessed germ tubes up to 20 μ long and 5 μ wide. The germ-cell swells up to a diameter of about 9 μ, and gives out one germ tube, as a rule, but very frequently two, one on each side of the germ-cell. In a culture twenty-four hours old germ tubes were seen which had a diameter of 5·5 μ (Plate X, figs. 2.3). a few spores were seen, which had swollen and colourless germ-cells but had not produced a germ tube. The time taken for a spore to germinate in water and nutrient solution is therefore approximately four hours, but the actual time depends on the individual spore.

Spores were grown in pure culture in Maize-meal agar, French-bean agar and Quaker Oat agar. Details of the growth on these media are given below.

Oat-agar. The agar slants were inoculated with spores from a pure culture. On the third day the hyphae have grown 8 mm. from the centre of inoculation along the surface of the medium in an almost imperceptible film and then produced an aerial fluffy growth forming a com-

plete ring. On the fifth day distinct zones of aerial hyphae are present, while the zone first formed appears greyish owing to the production of spores on the free hyphae. In some slants the zones are more distinct than in others. Growth in all of them, however, was luxuriant, giving the appearance of a heavy white felt lying on the medium. With age, the colour of the medium changes into a pale amber or creamy buff colour. On the tenth day, in addition to the abundant production of spores on the loose hyphae, small black pustules of spores are seen scattered about in some tubes, especially at the sides where the culture meets the glass. Old cultures show black bands consisting of mycelium bearing spores, and a profusion of pustules on the white zones between them. The hyphae do not ascend the sides of the tube for more than a few millimetres; spores are produced on these hyphae.

Microscopic examination. Pieces of the culture medium bearing pustules were microtomed. In section the spores are seen to be extruded from pycnidia. In the culture medium a stroma composed of interwoven hyphae is formed, 0·12 to 0·26 mm. deep. The pycnidia are embedded in this stroma in abundance, and also occur on the stroma and in the loose felt of mycelium on the medium. They occur singly or in groups, distinct or with common walls. They vary in shape, but are usually, spherical, globose, or oval, 0·26–0·35 mm. diameter, or up to 0·42 × 0·26 mm. The wall varies in thickness from 15 to 25 μ.

Spores. The length, including the terminal hyaline cells, was 16–24 μ, mean 20 μ; the coloured cells 11–15 μ, mean 13 μ, width 5–7 μ, mean 6·2 μ; pedicel present, varying in length from 4 to 10 μ; cilia 2 to 4 in number, rarely 2, generally 3 and up to 32 μ long; apex of cilia not knobbed.

The hyphae were hyaline, septate, branched and up to 5 μ in diameter; the spore-bearing hyphae were from 2 to 3 μ in diameter.

French-bean agar. The agar slants were inoculated with spores from a pure culture. On the third day the hyphae have grown 1 cm. from the point of inoculation and end in a fluffy growth. Thence they grow again along the surface of the medium for about 6 mm., and on the fifth day form another puff of aerial hyphae. This method of growth represents zoning. On the sixth day the fluffy growth of the first ring appears greenish or greyish in colour, owing to the formation of spores on free hyphae. Growth continues, forming regular distinct zones of aerial hyphae until the end of the tube is reached, and spores continue to be formed on the hyphae at the loose zones. By the twelfth day the whole surface of the medium is covered with a thin felt of white mycelium with black bands at regular intervals. The medium be-

comes darker in colour with advance in growth. Hyphae ascend the sides of the tube for a few millimetres only. When the culture is fourteen days old very minute black bodies begin to make their appearance on the thin white felt, appearing quite conspicuous on the white background.

Microscopic examination. The minute black bodies that appear on the felted layer are pseudo-parenchymatous stromata, containing a single lobed pycnidial cavity. They are situated in the mycelium on the surface of the medium, and may be pulvinate, flattened pulvinate, or globose. They attain a diameter up to 1·04 mm., and a height of 0·45 mm. The wall varies in thickness from 20 to 140 μ, and this variation may occur in the same stroma. In other respects, they agree with the stromata formed on other media. A pseudo-stroma or loose network of hyphae is formed in the culture medium to a depth of 0·13 mm. to 0·21 mm.

Spores. The length, including the terminal hyaline cells, was 17–25 μ, mean 19·8 μ; the coloured cells 10–16 μ; mean 13 μ; width 5–7 μ, mean 6 μ; pedicel varying in length from 3–7 μ; cilia 2–4 in number, usually 3 and up to 30 μ long; apex of cilia not knobbed.

The hyphae were hyaline, septate, branched and up to 6 μ in diameter. Spores are produced at the ends of free hyphae 2–3 μ in diameter (Plate X, figs. 4,5), or on closely-septate hyphae 4–6 μ in diameter.

Maize-meal agar. The agar slants were inoculated with spores from a pure culture. On the third day the mycelium has grown 1 cm. from the point of inoculation along the surface of the medium and ends in a fluffy growth. Thence it grows again for about 6 mm. and ends in scanty fluffy hyphae. This method of growth suggests zoning. By the eighth day the whole surface of the culture medium is overrun with loose hyphae. Hyphae collect here and there into small inconspicuous tufts and form a minute white body in the centre of each. Later from the centre of each white body a black speck arises, which is a mass of spores extruded in pustule form. When the culture is eight days old fructifications begin to appear, spores being seen in pustule form or borne on loose hyphae. When the culture is ten to twelve days old the mycelial growth is a loose, thin, white layer lying on the medium, studded irregularly with black pustules of spores. As growth advances, the medium becomes cream coloured. Hyphae ascend the sides of the tube for a few millimetres only.

Microscopic examination. In microtome sections the pustules of spores are found to be liberated from pycnidia, or from pseudo-parenchymatous stromata containing pycnidial cavities. A pseudo-stroma

consisting of a loose network of hyphae, 0·13–0·26 mm. deep, extends from the surface of the medium inwards. The pycnidia and pseudo-parenchymatous stromata occur in the loose hyphae overlying the medium. The pycnidia are spherical or globose, up to 160 μ diameter internally, with a wall 10–25 μ thick. The pseudo-parenchymatous stromata vary in shape, but are generally globose or laterally oval; they are up to 0·78 mm. in diameter and 0·38 mm. high, and contain a single pycnidial cavity which is usually irregularly lobed, enclosed by a wall 60–80 μ thick. The length of the spore, including the terminal hyaline cells, was 17–28 μ, mean 20·9 μ; the coloured cells 10–18 μ, mean 13·3 μ; width 5–8 μ, mean 6·4 μ; pedicel present, varying in length from 3–10 μ; cilia 2–4 in number, generally 3 and up to 40 μ long; apex of cilia not knobbed. The hyphae were hyaline, septate, branched and up to 6 μ in diameter. Spores were also borne at the ends of free hyphae about 3 μ in diameter, and on closely-septate hyphae about 5μ in diameter, the spores on the latter arising alternately below each septum (Plate X, fig. 6).

The following table gives the dimensions of the spores in nature and on the various culture media:—

Media.	Range of length including terminal hyaline cells.	Mean length.	Range of length of coloured cells.	Mean length.	Range in width.	Mean width.
Leaf in nature.	17–25 μ	20·7μ	11–17 μ	13·7 μ	5–8 μ	6·4 μ
Oat-agar.	16–24 μ	20·0μ	11–15 μ	13 μ	5–7 μ	6·2 μ
French-bean agar.	17–25 μ	19·8μ	10–16 μ	13 μ	5–7 μ	6·0 μ
Maize-meal agar.	17–28 μ	20·9μ	10–18 μ	13·3 μ	5–8 μ	6·4 μ

The vegetative growth in all these media differs entirely from that of *P. palmarum* in the formation of fluffy aerial hyphae and the production of spores on the loose hyphae. In all the media the number of cilia varies from 2 to 4, but the usual number is three, and the length up to 40 μ; the apex of the cilium is not knobbed and it could not be made to knob by growing the fungus on tea and coconut leaves, sterilised by boiling, in Roux tubes. A pedicel is always present and varies in length from 3 to 10 μ.

As the majority of the pustules of spores on the original diseased patch were those of *P. palmarum* and the pustules of this variety of spore with unknobbed cilia were comparatively very few and scarce it may be assumed that this spore is only a variant strain of *P. palmarum* and not a new species.

Bernard described *P. palmarum* from Java and gives his spore dimensions as 20–28 × 5–8 μ; pedicel 3 to 6 μ long; cilia three, rarely two and of varying length. Comparing the dimensions of his species with this strain, there does not appear to be much difference between the two.

INOCULATIONS

On coconut. Five inoculations from a fresh culture were made on the lower surface of cut leaves in a moist chamber, and five inoculations on the upper surface. Six inoculations were made on the uninjured lower surface of leaves of coconut plants, and five inoculations on the leaves after wounding with pin pricks. When examined twenty-two days later only two out of the five wounded inoculations had succeeded, and in these the spots did not extend further than 2 mm. from the edge of the wounded area. All the other inoculations failed. The control was free.

On tea. Five inoculations were made on the lower surface of plucked leaves in a moist chamber and five on the upper surface. Five inoculations were also made on wounds made by shaving off a small area of the epidermis with a razor. When examined twenty-two days later, no penetration of the fungus was evident.

In all 21 inoculations were made on coconut leaves, 11 on the lower surface of the leaf, 5 on the upper surface, and 5 on the leaf after wounding. The inoculations on the uninjured upper and lower surfaces of the leaf were all unsuccessful, while out of the 5 inoculations on the wounds, 2 were successful.

15 inoculations were made on tea leaves,—5 on the lower surface, five on the upper surface and 5 on the leaf after wounding. All were unsuccessful.

SUMMARY

Pestalozzia Theae in culture produces a rich fluffy growth of aerial hyphae, which ultimately form a thick, dense, compact felt of white mycelium lying on the medium. Pycnidia and pseudo-parenchymatous stromata are found chiefly in the stroma formed in the culture medium. Spores are also borne in large numbers on the loose hyphae. The cilia of the spores are knobbed in nature and usually knobbed in culture.

Those spores which possessed cilia without knobs in culture could be readily made to produce knobs by growing them on sterilized tea or coconut leaves. The cilia grow very long in culture, attaining lengths of 45 μ in the French-bean medium and 55 μ in the Tealeaf-juice medium. The length of the pedicel varies from 3 to 10 μ.

In cultures of *Pestalozzia palmarum* the hyphae accumulate in tufts. Pycnidia are produced in abundance in the loose mycelium on the medium and only very few in the stroma in the culture medium. The pustules of spores extruded from pycnidia are smaller than those extruded from the pycnidia of *P. Theae*. Spores are not borne on loose hyphae. The spores have knobbed cilia in nature, but those produced in culture had cilia without knobs. The latter spores could not be made to produce cilia with knobs by growing them on sterilized tea and coconut leaves. Once the spore is taken into culture the cilia grow short, rarely reaching 12 μ in length. The pedicel is not present in some spores in culture; when present it is generally between 1 and 3 μ long, rarely attaining 5 μ in length.

The vegetative growth of the variant strain on tea differs from that of *P. Theae* by the absence of the rich fluffy growth of aerial hyphae and by the absence of the formation of spores on loose hyphae. The spore is also slightly larger in width and length. The cilia vary in number from 3 to 6, are frequently branched and not inflated at the tip. No pedicel is visible; or, if present, it is so short that it is almost imperceptible. One characteristic of this spore is the peculiar swelling at the junction where the cilia originate. Unlike the spores of *P. Theae* and *P. palmarum*, water is unfavourable as a medium for spore germination and when germinnation does occur in water it is irregular. In the absence of spore formation on free hyphae this form resembles *Pestalozzia palmarum*.

The vegetative growth of the variant strain on coconut differs from that of *P. palmarum* in the formation of fluffy aerial hyphae and the production of spores on the loose hyphae. The mean dimension of the spore is also slightly greater. The apex of the cilium is not knobbed in nature and in culture and could not be made to knob by growing the spore on sterilized tea and coconut leaves. The cilia grew very long in culture attaining a length up to 40 μ. A pedicel is always present in culture and varies in length from 3 to 10 μ. In the formation of spores on free hyphae, and the length of the cilia in culture, this form resembles *Pestalozzia Theae*.

47 inoculations were made with *P. Theae* on uninjured tea leaf—17 on the upper surface and 30 on the lower surface. Every inoculation failed. 6 inoculations were made on petioles and these two were un-

successful. 15 inoculations were made after wounding the leaf, of which 12 proved successes.

24 inoculations were made on the uninjured coconut leaf and all proved failures. 6 inoculations made after wounding were successes.

It would appear from these inoculations that *P. Theae* could infect tea and coconut leaves through a wound, but is unable to penetrate the healthy leaf under ordinary conditions.

26 inoculations were made with *P. palmarum* on the uninjured coconut leaf—17 on the lower surface and 9 on the upper surface. All were failures. 14 inoculations were made after wounding and all were successful.

32 inoculations were made on the tea leaf—21 on the upper surface and 11 on the lower surface after wounding and 10 inoculations without wounding. All proved failures.

From the inoculation experiments it could be deduced that *P. palmarum* could attack coconut leaves through a wound, but is unable to penetrate the healthy tissue under the condition of the experiment. The failure of the inoculation on the tea leaf indicates that the fungus is not parasitic on tea.

To Mr. T. Petch, B.Sc., B.A., Government Mycologist and Botanist, I have to express my gratitude for assistance in carrying out these investigations and in the preparation of the manuscript.

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DESCRIPTION OF THE PLATES

PLATE V. *Pestalozzia Theae* Sawada.

Fig. 1. Section through a pycnidium on the stroma formed in the medium liberating spores into the culture medium, ×42.

,, 2. Section through chambered pycnidia on the pseudo-stroma showing spores being liberated by a rupture of the wall and confined under the woolly hyphae, ×18.

,, 3. Section through a stromatic body containing pycnidial cavities, ×42.

,, 4. Section through a flask-shaped pycnidium on the stroma formed in the medium, ×230.

,, 5. Section through chambered pycnidia on the pseudo-stroma extruding spores to the top by a rupture of the wall, ×36.

, 6. Section through a pycnidium embedded in the stroma liberating spores into the culture medium, ×55.

PLATE VI. *Pestalozzia palmarum* Cke.

Fig. 1. Section through a group of pycnidia in the film of mycelium on the medium, ×173 (long axis of figure horizontal).

, 2. Section through a flask-shaped pycnidium in the film of mycelium on the medium, ×230.

,, 3. Section through a rectangular-oval pycnidium in the film on the medium with a small spheroidal pycnidium attached to it, ×260.

Fig. 4. Section through a globose pycnidium in the film on the medium showing spores being liberated by a break in the wall. A small spheroidal pycnidium at the side, ×335.

,, 5. Section through a spherical pycnidium embedded in the stroma formed in the medium, ×385.

,, 6. Section through a spheroidal pycnidium in the film on the medium, ×230.

PLATE VII. Variant Strain on Tea.

Fig. 1. Section through a stromatic body containing pycnidial cavities situated on the stroma, ×39.

,, 2. Section through a pycnidium embedded in the culture medium, ×62.

,, 3. Section through a pycnidium embedded in the culture medium liberating spores by a break in the wall into the culture medium, ×215.

, 4. Section through a young pycnidium showing pseudo-parenchymatous structure of the wall, ×250.

,, 5. Section through a pycnidium partly embedded in the stroma liberating spores by an opening at the base into the stroma forming a cavity full of mature spores, ×38.

Figs. 6,7. Sections through pycnidia partly embedded in the stroma. One liberating spores to the exterior by a rupture of the wall at the side, ×35.

PLATE VIII. *Pestalozzia* spores in nature and in culture.

Fig. A. *Pestalozzia* spores on tea leaf in nature with knobbed cilia. One abnormal spore with 5 coloured cells, ×830.

,, B. *Pestalozzia* spores on coconut leaf in nature with knobbed cilia, ×830.

,, C. *Pestalozzia* spores from coconut in culture, ×830.

,, D. *Pestalozzia* spores with knobbed cilia grown from spores with unknobbed cilia, on sterilized tea leaf, ×830.

,, E. Spores of *Pestalozzia* on tea borne on hyphae in culture. ×830.

PLATE IX. *Pestalozzia Theae* Sawada and the variant strain on tea.

(a) Variant Strain.

Fig. 1. Abnormal spore with one coloured cell in Maize-meal agar culture, ×950.

Figs. 2, 4, & 5. Spores in culture, ×950.

Fig. 3. Abnormal spore with 5 coloured cells hatched on sterilised coconut leaf, ×950.

Figs. 6,7. Spores germinating in nutrient solution 17 hours old, ×950.

Fig. 8. Spore germinating in water, 60 hours, ×950.

(b) *P. Theae.*

Fig. 9. Spore germinating in Tea leaf juice agar, ×950.

,, 10. Spore germinating in nutrient solution 17 hours, ×950.

,, 11. Spore germating in distilled water 17 hours, ×950.

PLATE X. *Pestalozzia palmarum* Cooke and the Variant Strain on coconut.

(a) Variant Strain.

Fig. 1. Spore germinating in distilled water, 24 hours, ×950.

Figs. 2 & 3 Spores germinating in nutrient solution 24 hours, ×950.

,, 4 & 5 Spores borne on loose hyphae in French-bean agar culture, ×950.

Fig. 6. Spore borne on loose hyphae in Maize-meal agar culture, ×950.

(b) *Pestalozzia palmarum.*

Figs. 7 to 10. Spores germinating in nutrient solution. 24 hours, ×950.

,, 11 to 13. Spores germinating in distilled water. 24 hours, ×950

APPENDIX

Dextrose meat-extract agar.

Peptone	5	grm.
Sodium chloride	2·5	grm.
Lemco	2	grm.
Dextrose	10	grm.
Agar agar	7·5	grm.
Water	500	c.c.

Standard Nutrient solution.

Ammonium nitrate	1	grm.
Potassium biphosphate	·5	grm.
Magnesium sulphate	·25	grm.
Cane sugar	5	grm.
Water	100	c.c.
Iron chloride		trace,

Tea leaf-juice agar

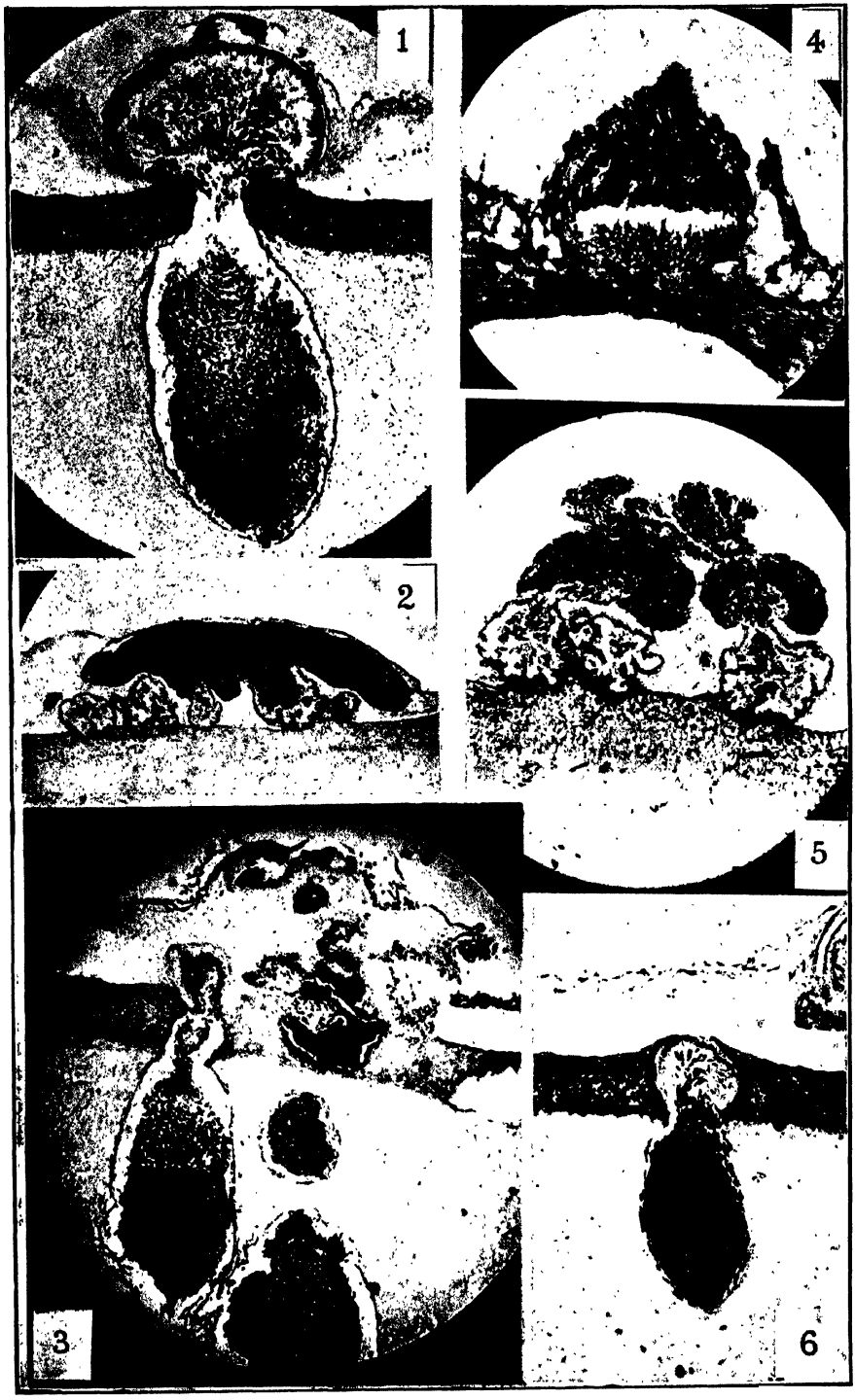
100 grammes of tea leaves were cut into pieces and boiled with 300 c.c. of water for forty minutes in a saucepan, water being added to make up for loss due to evaporation. The juice was filtered through a muslin cloth, 6 grammes of agar added and enough water to make up to 400 c.c. and mixed by boiling again.

Maize-meal agar. (25-5-250)

25 grammes of crushed Maize seed and about 250 c.c. of water were boiled in a saucepan for about forty minutes, water being added to make up for loss due to evaporation. 5 grammes of agar was dissolved by heating in a beaker in 150 c.c. of water. The Maize mixture was filtered through a muslin cloth, the content squeezed out, mixed with the agar, and water added to make up to 250 c.c.

Quaker Oat-agar. (25-5-250).
French-bean agar (25-5-250). Prepared as Maize-meal agar.

All the media were tubed and autoclaved at 115° for 20 minutes.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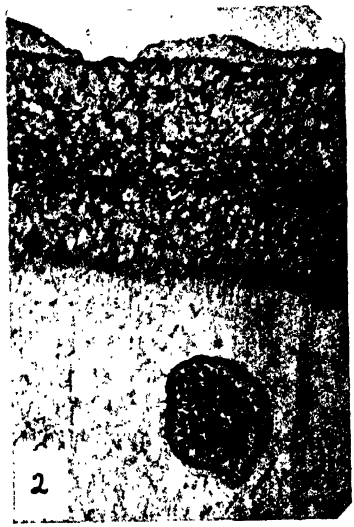
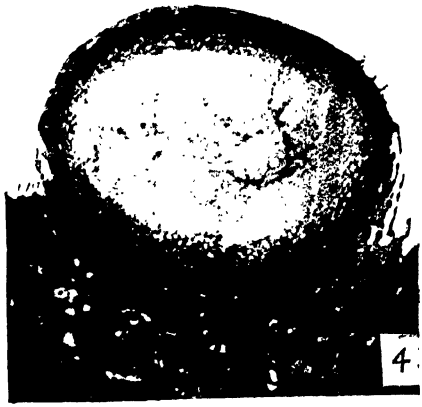
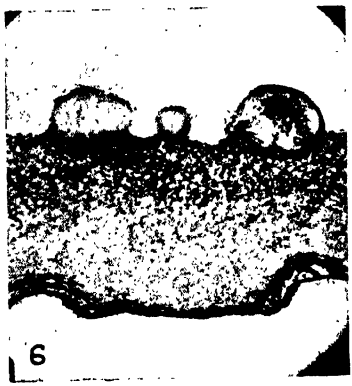
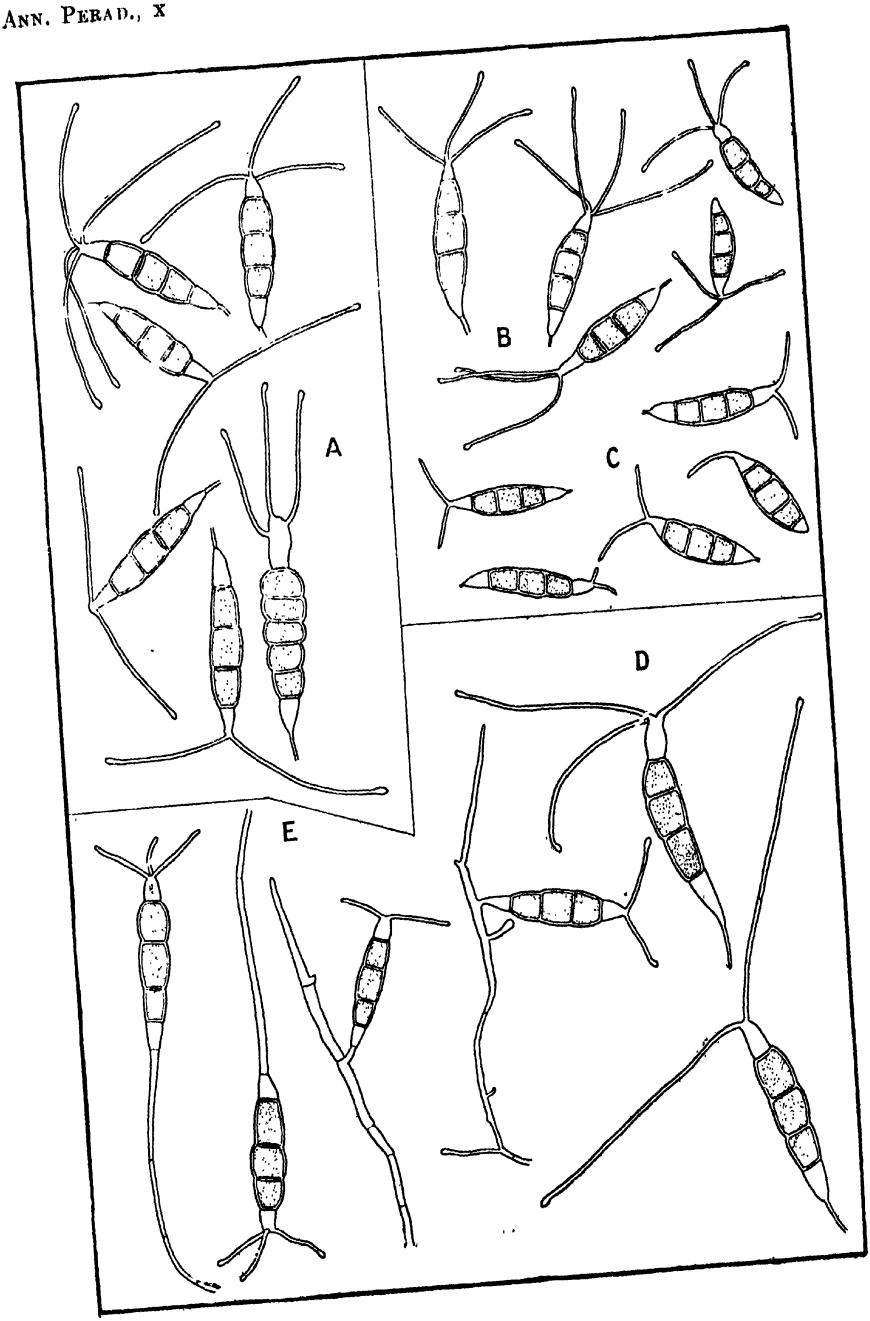


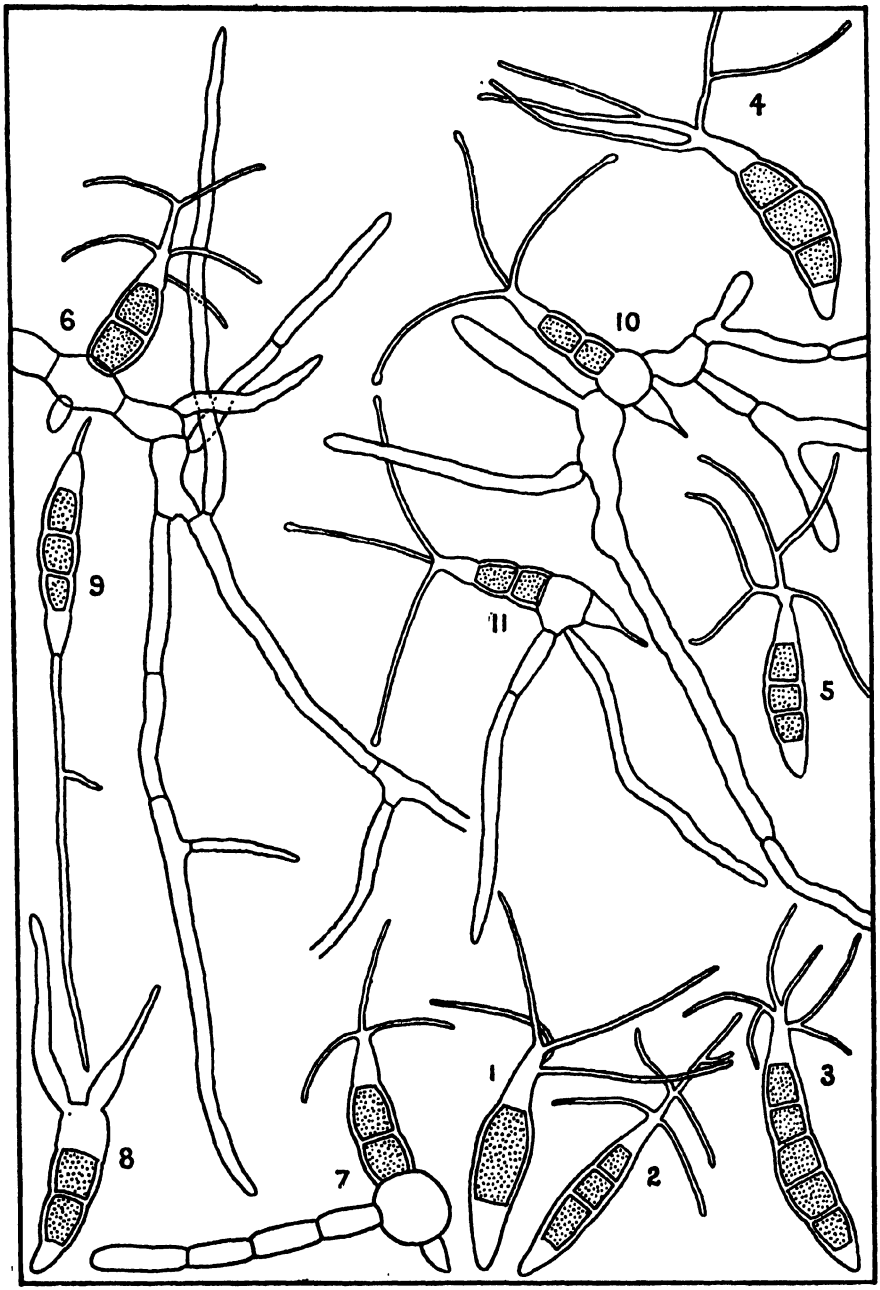




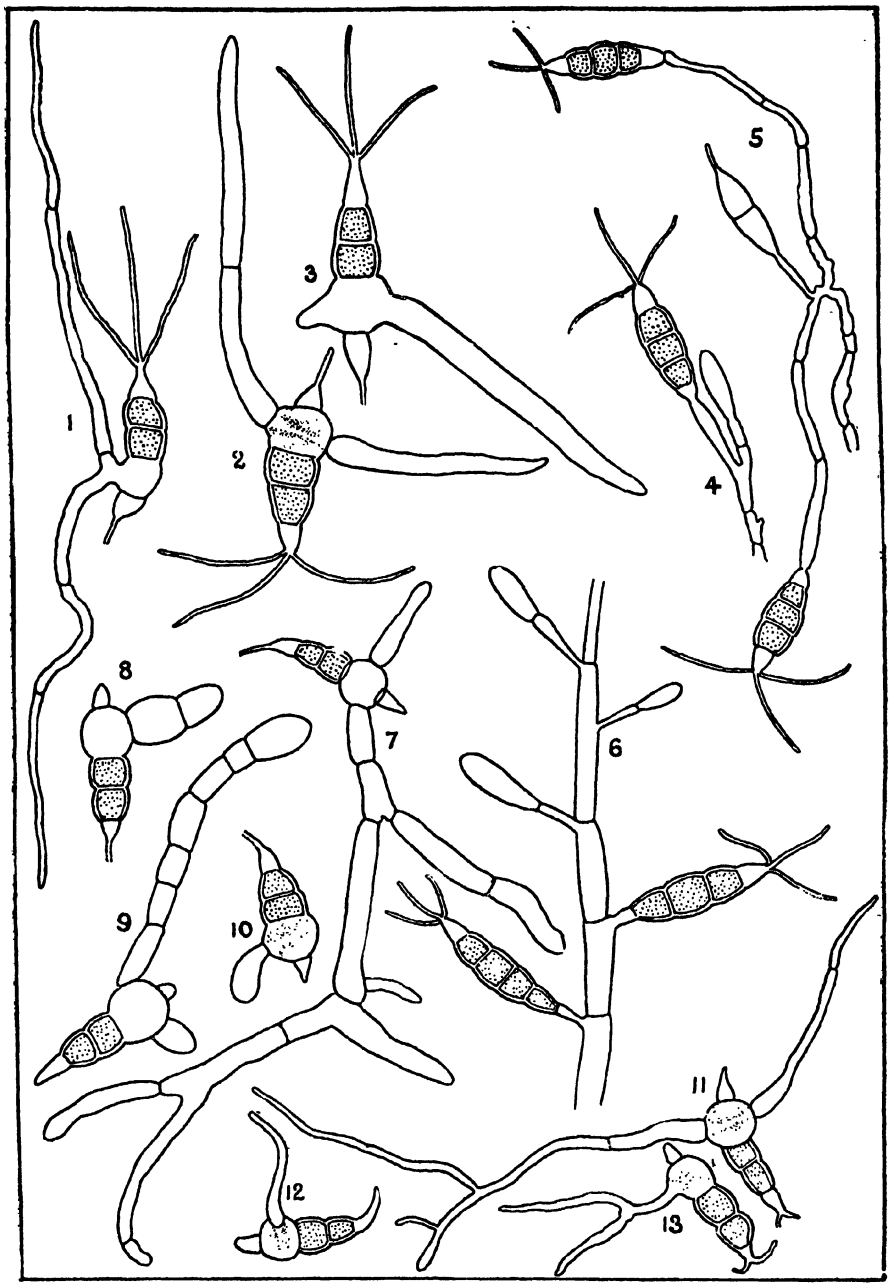
Photomicrograph by L. S. Bertus.



Pestalozzia spores in nature and in culture



Pestalozzia theae. Sawada and the variant strain on tea



Pestalozzia palmarum Cooke and the variant strain on coconut

Some Observations on the Oospores of Phytophthora Species *

BY

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WITH TWO PLATES

INTRODUCTION

Leonian, in his recent work (6), has used physiological growth characters almost entirely for the separation of the various species of *Phytophthora*. Until the appearance of his paper, the measurable characters of the various spore forms were the chief morphological grounds upon which such work had been based. Especially is this true in the case of the sexual spores (oospores) of those species in which they are known. The factors which actually determine the production of these sexual reproductive bodies are not yet definitely apparent. *Phytophthora palmivora* Butler, *P. faberi* Maublanc, and *P. nicotianae* Br. de Haan are three forms about the oospores of which little or nothing is known. In view of this, any addition to our knowledge of the size and development of the oospores of these forms is both valuable and of interest. *P. palmivora* and *P. faberi* are considered by Butler (3) to be at most strains of one species, and this view is held by Ashby and Gadd. In this paper forms of this species are, for simplicity, termed strains of *P. faberi*; but, as is mentioned later, the species should be known as *P. palmivora* Butler. The results here set out confirm this view as the oospores of each of the three strains of *P. faberi* used are alike in size and development.

THE OOSPORES OF P. FABERI

Ashby (1), in 1922, was the first to record oogonia and antheridia of *P. faberi*. Oospores, the mean size of which was 23.3 microns,

* These observations were made during the tenure by the author of a Senior studentship, under The Empire Cotton Growing Corporation, at the Imperial College of Tropical Agriculture, Trinidad, 1924-1925. The work was undertaken at the suggestion of Professor S. F. Ashby, B. Sc., Microbiologist at the College.

The author is very much indebted to him for his kind and most able guidance throughout the work.

developed in mixed cultures of (i) *P. faberi* and *P. palmivora*, (ii) *P. faberi* and a species of *Phytophthora* isolated from cotton in St. Vincent, and (iii) *P. faberi* and *P. parasitica* from castor in India. *P. palmivora* and the species from cotton in St. Vincent are apparently identical, and they differ from *P. faberi* only in definite growth characters. As a result of the formation of oospores in the mixtures (i) and (ii), Ashby suggested the possibility of heterothallism in *P. faberi*. This, however, was not supported by the development of oospores of *P. faberi* in mixture (iii).

The following sentences which give the key to the use of the term heterothallism in this paper are inserted for the sake of clarity. Blakeslee (2), working with some of the *Zygomycetes*, demonstrated that certain species consisted of two strains or races which, when grown apart, produced only asexual spores, but formed sexual spores when hyphae from the two physiologically different mycelia were allowed to come into contact. Such species he termed heterothallic species in contrast to the homothallic species producing sexual spores from the single mycelium. Furthermore, in cases in which sexually opposite strains of two different species were allowed to come into contact only attempts at hybridization took place, and in no case was a sexual spore formed. In cases in which like strains of different species were allowed to come into contact, no attempts at hybridization were noted. *P. parasitica* was at this time regarded as a distinct species, but, according to Leonian (loc. cit), *P. parasitica*, *P. palmivora*, *P. faberi*, and several other species are regarded as belonging to the same species-group (*P. omnivora*). He admits, however, the necessity of the group being split up into the two sub-groups (a) *Parasitica*, including amongst others *P. parasitica* and *P. terrestris*, and (b) *Colocasiae*, to include *P. faberi*, *P. palmivora*, etc. If this arrangement be accepted and heterothallism be regarded as probable in the *colocasiae* sub-group, all the homothallic forms belonging to the species-group *P. omnivora* will of necessity belong to the *parasitica* sub-group. As far as present information goes, this is apparently so; and, if this be correct, the production of oospores by a *faberi* strain in mixed culture with a homothallic *parasitica* strain cannot be interpreted by a theory of heterothallism. Gadd (5), in 1924, strongly inclined to the hypothesis of heterothallism in *P. faberi*, but did not grow strains of this fungus in mixed cultures with a distinct species or with a known homothallic strain.

The purpose of the observations now reported was to repeat and extend observations on oospore production in cultures of *P. faberi* strains mixed with *P. parasitica* strains. If strains of *P. faberi* produce oospores in such mixtures heterothallism would not be indicated in

P. faberi. Another explanation appears to be called for in this case and the following theory is put forward :—that the formation of oospores is due to the influence of the one vegetation on the other, acting through its effect on the medium or on certain constituents of the medium.

Strains used in the mixed cultures

Some seven presumed strains of *P. parasitica* and three of *P. faberi* were available, and mixed cultures of each of the *parasitica* strains with each of the *faberi* strains were grown. A number of the *parasitica* strains, however, failed to produce oospores in pure cultures or developed them too scantily to afford reliable data in regard to mean size and variation. The data recorded, therefore, are restricted to three *parasitica* strains which developed oospores in pure cultures in numbers sufficient to enable their mean size and range to be determined. The mixed cultures of these three strains with each of the three *faberi* strains yielded oospores in ample numbers.

The three *parasitica* strains. (Subsequently referred to as *parasitica* I, II, and III.)

I. *P. terrestris* Sherb.

A culture from W. S. Beach of Pennsylvania University, supplied to him by Sherbakoff, and isolated from tomato fruit in Florida affected by " buckeye " disease. This species is regarded by Ashby, Bewley, and Dastur as indistinguishable from *P. parasitica* Dast. and is treated here as a *parasitica* strain.

II. *P. parasitica* strain.

A strain isolated by Ashby in 1923 from the vascular system of a banana plant in Trinidad which was attacked by a *Fusarium* wilt (Panama disease.)

III. *P. parasitica* strain.

A strain isolated in 1920 by Miss E. M. Wakefield from a " boll-rot " of cotton in Montserrat.

The three *faberi* strains (all isolated by Prof. Ashby and subsequently referred to as *faberi* I a and b, 2 a and b, and 3.)

1. *P. faberi* strains, a and b.

Two isolations made in 1924 and 1925 respectively, from " pod-rot " of cacao in Trinidad.

2. *P. faberi* strains, a and b.

Two isolations, maintained in pure culture since 1919, from a " bud-rot " of the coconut palm in Jamaica.

3. *P. faberi* strain.

A strain isolated in 1922 from a " boll-rot " of cotton in St.Vincent.

Media

Lima-bean, maize-meal and quaker-oats agars were used as the standard media. Their composition was :—lima-bean, forty to fifty grams of ground dry beans ; quaker oats, twenty-five grams ; maize-meal, twenty-five grams of American (germ-free) corn-meal. The agars were prepared from these substances by the addition of five hundred cubic centimetres of tap or distilled water and the whole heated to boiling-point. Seven and a half grams of " Bacto " agar were added and dissolved, the whole strained through muslin or cheese-cloth and sterilized in an autoclave at 12 to 15 lbs. pressure for 20 minutes.

Pure Cultures

Pure cultures of the *parasitica* strains I, II, and III developed oospores abundantly on bean-agar after from two to three months, growth at room temperature. The mean room temperature of the laboratory where the cultures were kept was about 79°F, and the variation from 70 to 86°F. On quaker-oats agar all three strains produced oospores much less freely, and only scantily or not at all on maize-meal agar. Pure cultures of the *faberi* strains failed to develop oospores on all media, a finding which is in agreement with the observations of Ashby and Gadd. Tables A and B give all the available data for the pure cultures of the *parasitica* strains I, II, and III.

TABLE A

parasitica strain.	No. measured.	Medium and temp.	Age of culture in mths.	Mean in microns.	Standard error.	Range.
parasitica I.						
(1)	200	Bean agar. Ice chest.	2	18·24	·253	14·4—22·5
(2)	113	Quaker oats. agar. Room temp.	5¼	17·99	·185	13·0—22·5
(3)	50	Bean agar. Room temp.	5	18·6	·384	14·4—22·5
parasitica II.						
(4)	50	Bean agar. Room temp.	4½	18·24	·437	14·4—21·6
parasitica III.						
(5)	34	Bean agar. Room temp.	5¾	18·3	—	15·6—21·8
	363			91·37		
				18·27		

TABLE B

frequency arrays

Serial Nos. of cultures. Microns.	1.	2.	4.	Totals.
13—14·9	11	1	4	16
15—16·9	35	19	13	67
17—18·9	114	41	17	172
19—20·9	26	41	9	76
21—22·9	14	11	7	32
23 or over	nil.	nil.	nil.	—
Totals	200	113	50	363

Mixed Cultures

The mixed cultures are numbered serially throughout. Tables C and D give all the data for the mixed cultures of the *faberi* strains with *faberi* strains.

TABLE C

Faberi *strain*+faberi *strain mixtures*

1a and 1b are strains from cacao.
2a and 2b are strains from coconut.
3 is a strain from cotton.

Serial No.	Mixtures.	Medium & temp.	Age of culture in mths.	No. of oospores measured.	Place on slant.	Mean microns.	Standard error.	Range in microns.
1	1a+2a	Bean agar. Ice chest.	1½	100	Middle.	21·48	·230	18·0—28·8
2	1a+2b	Bean agar. Ice chest.	1½	100	Middle.	22·25	·292	16·0—28·8
3	1b+2a	Bean agar. Ice chest.	1	100	Middle.	21·9	·224	18·0—28·8
4	1b+2a	Bean agar. Room temp.	1½	132	Apex & Middle.	22·07	·300	17·1—30·6
5	1b+2b	Bean agar. Ice chest.	1	100	Middle.	22·04	·239	18·0—28·8
6	1b+2b	Bean agar. Room temp.	1½	100	Middle.	22·63	·204	18·0—28·8
7	1a+3	Bean agar. Ice chest.	1½	100	Middle.	22·27	·210	18·0—27·0
8	1b+3	Bean agar. Ice chest.	1	150	Middle.	21·08	·158	16·2—25·2
9	1b+3	Bean agar. Room temp.	1	100	Middle.	22·99	·243	17·1—29·7
				982		198·71		
						22·08		

TABLE D

Frequency arrays

Serial Nos.	1.	2.	3.	4.	5.	6.	Totals. 1—6	7.	8.	9.	Totals. 7—9	Complete totals. 1—9
Microns.												
Under 17	—	1	—	—	—	—	1	—	1	—	1	2
17—18·9	9	9	11	13	10	5	57	7	24	4	35	92
19—20·9	24	17	16	25	21	14	117	16	39	10	65	182
21—22·9	25	30	39	46	34	34	208	30	55	44	129	337
23—24·9	30	25	23	34	20	31	163	38	23	20	81	244
25—26·9	9	14	8	8	9	11	59	7	8	15	30	89
27—28·9	3	4	3	5	6	5	26	2	—	5	7	33
29—30·9	—	—	—	1	—	—	1	—	—	2	2	3
Totals	100	100	100	132	100	100	632	100	150	100	350	982

Tables E and F give all the data for the mixed cultures of the *parasitica* strains with *faberi* strains.

TABLE E

1a & 1b are *faberi* strains from cacao.
2a & 2b are *faberi* strains from coconut.
3 is a *faberi* strain from cotton.
I is a *parasitica* strain from tomato. (*P. terrestris*).
II is a *parasitica* strain from banana.
III is a *parasitica* strain from cotton.

Serial No.	Strains Mixed.	Medium and temp.	Age of culture in mths.	No. of oospores measured.	Place on slant.	Mean in microns.	Standard error.	Range in microns.
10	1 & 1a	Maize-meal. Ice chest.	2	50	Apex.	20·58	·288	16·2—28·8
11	1 & 1a	Quaker oats. Room temp.	3½	50	Apex.	21·12	·304	16·2—25·2
12	1 & 1b	Quaker oats. Ice chest.	2	50	Apex.	19·76	·327	17·3—25·9
13	1 & 1b	Quaker oats. Room temp.	3	50	Apex.	19·64	·231	16·2—23·4
14	1 & 1b	Maize-meal. Ice chest.	2	50	Apex.	20·54	·295	16·2—26·4
15	1 & 1b	Maize-meal. Ice chest.	4	100	Apex.	21·13	·242	14·4—28·8
16	1 & 1b	Maize-meal. Ice chest.	4	100	Apex.	21·75	·322	14·4—30·6
17	1 & 1b	Bean. Room temp.	2	50	Apex.	19·2	·227	16·2—23·4
18	1 & 2a	Bean. Ice chest.	1	100	Apex.	19·28	·142	16·2—25·2
19	1 & 2a	Bean. Room temp.	1	100	Apex.	19·53	·187	15·3—24·3
20	1 & 2a	Bean. Room temp.	1	100	Middle.	18·62	·153	14·4—23·4

TABLE E—(*Contd.*)

Serial No.	Strains Mixed.	Medium and temp.	Age of culture in mths.	No. of oospores measured.	Place on slant.	Mean in microns.	Standard error.	Range in microns.
21 i	1 & 2a	Maize-meal. Ice chest.	5½	114	Upper-half.	23·54		18·2—31·2
ii	1 & 2a	Maize-meal. Ice chest.	5½	67	Upper-half.	22·3		18·2—27·3
iii (i & ii)	1 & 2a	Maize-meal. Ice chest.	5½	181	Upper-half.	23·08		18·2—31·2
22	1 & 2b	Bean. Ice chest.	1	100	Apex.	19·33	·148	16·2—22·5
23	1 & 2b	Bean. Room temp.	1	100	Apex.	19·38	·204	14·4—25·2
24	1 & 2b	Maize-meal. Ice chest.	5½	37	Upper-half.	23·6		18·2—31·2
25	1 & 3	Maize-meal. Ice chest.	2	50	Apex.	24·02	·329	19·8—28·8
26	1 & 3	Quaker oats. Room temp.	3½	50	Apex.	21·64	·705	18·0—28·8
27	1 & 3	Bean. Ice chest.	1	100	Apex.	19·25	·171	14·4—24·3
28	1 & 3	Bean. Room temp.	1	100	Apex.	18·34	·181	14·4—25·2
29	1 & 3	Maize meal. Ice chest.	5½	86	Upper-half.	22·92	—	17·0—33·8
30	II & 1a	Maize meal. Ice chest.	2½	50	Apex.	22·68	·467	16·2—31·5
31	II & 1a	Quaker oats. Room temp.	3½	50	Apex.	20·72	·583	14·4—30·6
32	II & 1b	Bean. Room temp.	3	50	Apex.	18·88	·190	16·2—21·6
33	II & 1b	Quaker oats Ice chest.	2	50	Apex.	20·76	·348	15·3—32·4
34	II & 1b	Quaker oats. Room temp.	3½	50	Apex.	21·0	·408	16·2—28·8
35	II & 1b	Maize-meal. Ice chest.	2	50	Apex.	23·44	·558	18·0—32·4
36	III & 1a	Maize-meal. Ice chest.	2¾	50	Apex.	22·52	·632	14·4—32·4
37	III & 1b	Bean. Room temp.	2½	50	Apex.	18·04	·242	14·4—21·6
38	III & 1b	Quaker oats. Room temp.	4	36	Apex.	20·05	·316	18·0—25·2
39	III & 1b	Quaker oats. Ice chest.	2	50	Apex.	20·46	·303	17·0—24·3
40	III & 1b	Maize-meal. Ice chest.	2	50	Apex.	21·2	·303	18·0—25·2

Note.—In culture No. 21 the sub-groups i and ii represent separate samples from the one culture, sub-group iii is the complete total for these first two. I am indebted to Prof. Ashby for the results of this culture and also of cultures Nos. 24 and 29 none of which had produced oospores when I left the College.

TABLE

Serial Nos.	10	11	12	13	14	15	16	17	Totals 10—17	18	19	20	21 (iii)	22	23	24	To 18-
Microns under 15.	—	—	—	—	—	1	1	—	2	—	—	2	—	—	3	—	
15—16·9	1	1	—	3	1	2	4	5	17	4	8	12	—	9	9	—	
17—18·9	14	9	16	20	15	22	15	24	135	49	44	64	8	36	39	2	2
19—20·9	12	10	16	11	8	17	24	11	109	35	19	11	37	32	25	7	1
21—22·9	20	18	9	14	20	37	26	8	152	10	22	9	53	23	16	10	1
23—24·9	2	8	2	2	4	14	11	2	45	1	7	2	44	—	7	7	
25—26·9	—	4	7	—	2	6	11	—	30	1	—	—	17	—	1	4	
27—28·9	1	—	—	—	—	1	7	—	9	—	—	—	16	—	—	3	
29—30·9	—	—	—	—	—	—	1	—	1	—	—	—	4	—	—	3	
31—32·9	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	1	
over 33	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	50	50	50	50	50	100	100	50	500	100	100	100	181	100	100	37	7

General Observations

That oospores of the *faberi* strains were produced in these mixed cultures seems very evident. Frequency arrays show definitely that in the mixtures of the cultures of *P. faberi* from cacao with the three *parasitica* strains oospores of *P. faberi* were present in cultures Nos. 10, 14, 15, 16, 30, 31, 33, 34, 35, 36, and probably in cultures Nos. 11, 12, 38, 39, and 40. It is also evident that the great majority of oospores in cultures Nos. 17, 32 and 37 were due to *parasitica* alone, and these, it should be noted, were on bean-agar. In the mixtures of the *faberi* strain from cotton (St. Vincent) with a *parasitica* strain it is practically certain that all the oospores in culture No. 25 were those of *faberi*; and also that the great majority of those in cultures Nos. 26 and 29 were *faberi*. In cultures Nos. 27 and 28, both on bean-agar, the majority of the oospores were those of *parasitica*.

FREQUENCY ARRAYS

	26	27	28	29	Totals 25—29	30	31	32	33	34	35	Totals 30—35	36	37	38	39	40	Totals 36—40	Complete Totals 10—40
·	—	1	3	—	4	—	1	—	—	—	—	1	2	4	—	—	—	6	18
·	—	9	19	—	28	1	7	6	2	3	—	19	2	12	- -	—	—	14	120
·	8	43	45	3	99	6	18	27	9	11	3	74	3	27	12	18	9	69	619
1	6	26	15	19	70	4	6	10	14	9	8	51	12	2	14	12	14	54	450
0	20	17	14	18	79	18	6	7	17	17	8	73	13	5	6	10	17	51	498
4	12	4	3	35	68	9	1	—	5	3	8	26	4	—	2	10	5	21	228
7	3	—	1	6	27	6	4	—	1	4	11	26	6	—	2	—	5	13	119
5	1	—	—	2	8	3	5	—	1	3	5	17	2	—	—	—	—	2	55
-	—	—	—	1	1	2	2	—	0	—	2	6	3	—	—	—	—	3	18
-	—	—	—	1	1	1	—	—	1	—	5	7	3	—	—	—	—	3	14
-	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1
0	50	100	100	86	386	50	50	50	50	50	50	300	50	50	36	50	50	236	2,140

The inoculations for the mixed cultures were made, as also in the case of the pure cultures, with fragments of agar from pure cultures on agar slants. With the pure cultures the inoculation was, as far as possible, made on the middle of the slant. With the mixed cultures the two inoculations were, as far as possible, made equidistant from each other and from the top or bottom of the slant respectively. In the case of the mixtures of the *faberi* with the *parasitica* strains, the *faberi* strain was in every case inoculated first, and on the centre of the lower half of the slant, the *parasitica* strains being inoculated on the centre of the upper half. In the tables of these mixtures (tables C and E), the position on the slant from where the oospores measured were obtained is shown. This is a point of importance, as, in the case of the oospores obtained from the apices of the slants, one would expect the mean to show a low tendency due to a predominance of the oospores of the *parasitica* strains; and such is in most cases apparent.

Conclusions

From the results of these cultures it is apparent that the strains of *parasitica* used, in pure culture, give a mean size for the oospores of approximately 18.0 microns with a range of from 13·0 to 22·9 microns. The results of the mixtures of the *faberi* strains alone may be regarded as equivalent to results, could they be obtained, of pure cultures of *faberi* strains; and these results give a mean size for the definitely amphigynous oospores of approximately 22·0 microns with a range of from 16·0 to 33·8 microns. In the mixtures of the *parasitica* with the *faberi* strains, there is evidence of an increase in the mean size of the oospores with the age of the culture. This was especially noticeable in cultures Nos. 21, 24, and 29 in table E which are five and a half months old; and there was no indication of this in the pure cultures of the *parasitica* strains (table A). This rather indicates that oospores of the *faberi* strains go on developing after those of the *parasitica* strains have ceased; and this tendency was to a slight extent noticeable in the mixed cultures of the *faberi* strains alone (table C). It was also apparent that bean-agar favoured the production of *parasitica* oospores and maize-meal agar the production of *faberi* oospores; this makes the latter medium preferable for mixed cultures and confirms Gadd's good results with it.

The following short table, extracted from tables E and F, shows the results on maize-meal agar of each of the three *faberi* strains mixed with *parasitica* strains in those cultures where it was evident that the great majority of the oospores measured were those of the *faberi* strains :—

Serial No.	*faberi* strain.	*parasitica* strain.	Age of culture (mths).	No. of oospores.	Mean on microns.	Range.
16	1b, cacao	I, tomato	4	100	21·75	14·4—30·6
30	1a, cacao	II, banana	2½	50	22·68	16·2—31·5
35	1b, cacao	II, banana	2	50	23·44	18·0—32·4
36	1a, cacao	III, cotton	2¾	50	22·52	14·4 - 32·4
21 (iii)	2a, coconut	I, tomato	5½	181	23·08	18·2—31·2
24	2b, coconut	I, tomato	5½	37	23·60	18·2—31·2
25	3, cotton	I, tomato	2	50	24·02	19·8—28·8
29	3, cotton	I, tomato	5½	86	22·92	17·0—33·8
					8)184·01	
					23·00	

In two of these mixed cultures oospores of the *parasitica* strain were definitely present (indicated by a minimum of 14·4 microns) and tended to lower the mean size and widen the range. This table shows conclusively that all three *faberi* strains have produced oospores abundantly when grown independently with *parasitica* strains. It also furnishes almost definite proof that the strains from cacao, Trinidad, "bud-rot" of coconut, Jamaica, and " boll-rot " of cotton, St. Vincent, belong to one species.

These results compare very favourably with those of Ashby (loc. cit., table on page p. 261, cultures Nos. 8 to 11, and 16). For his mixed cultures, sub-cultures of the same isolation from coconut were used but with a different isolation from cacao growing in Grenada. They are also comparable with the results of Gadd (loc. cit., table 6, p. 73). The description and naming of the coconut and palmyra strain by Butler (*Pythium palmivorum*, referred by him to *Phytophthora* in 1919 dates from 1907, and the description and naming of the cacao strain by Maublanc (*Phytophthora faberi*) dates from 1909. The species should, therefore, on grounds of priority be known as *Phytophthora palmivora* Butler.

It is not considered that these results show any definite evidence of hybridism. That hybridisation had not taken place seemed apparent during the examination of the cultures and measuring of the oospores ; and this, it is considered, is brought out quite clearly in the frequency arrays. With other members of the *Phycomycetes*, Blakeslee (loc. cit.) never obtained perfect hybrid sexual spores and Burgeff (3), only by means of a very elaborate technique, obtained graft hybrids which never produced any sexual spores. In view of these facts, the omission of any consideration of hybridism is perhaps justifiable.

It is held that oospores of all the *faberi* strains were formed in these mixed cultures, thus substantiating the views of Ashby and Gadd. The abundant evidence afforded by the cacao strain of *P. faberi*, and the evidence from cultures Nos. 25, 26 and 29 in table F that the *faberi* strain from cotton develops oospores when grown with a very different species, and its very close affinity with the coconut strain, suggest that all strains of *faberi* might be induced to develop oospores when grown with strains of such a distinct species as *parasitica*. The formation of oospores by the *faberi* strains here reported cannot be accounted for by the theory of the heterothallism of *P. faberi* in view of the fact that they are formed in the mixtures of strains of this fungus with known homothallic strains. What the factors are that induce oospore formation in mixed cultures by *faberi* strains which do not produce them in pure cultures remains an open question. The view here put forward is that the formation of these sexual organs is related to the rate of metabolism of the thallus which is largely influenced by environment. The view is held that a normal strain of *P. faberi* is capable of both asexual and sexual reproduction; that the former is induced by a high rate of metabolism characterised by a high water content and a certain ratio of food materials ; the latter by a low rate of metabolism characterised by a low water content, a different ratio of food materials, and possibly a low temperature. The rate of metabolism will be greatly influenced by the presence or absence of a competing organism, especially when the requirements of the two

growths approximate more closely to each other. This is ultimately in accordance with the observations of Murphy (7) on *P. erythroseptica*, that a nutritional check to the vegetative growth has initiated the sexual reproductive phase.

THE OOSPORES OF P. NICOTIANAE

Some observations were also made on mixed cultures containing *P. nicotianae* Br. de Haan. This species has been known for many years as the cause of serious losses in the susceptible "Deli" tobacco in the seed-bed and field in Sumatra, and of more occasional damage to other varieties in Java. *P. nicotianae* was for many years regarded as highly specialised in host range having been definitely observed only on tobacco. Fairly recently it was found attacking castor oil plants (*Ricinus communis*) in the seed-bed in Sumatra and was successfully inoculated on tomato. During recent years it has attacked tobacco in Florida, and the culture used had been isolated by W. S. Tisdale from tobacco in that area. It was kindly sent to Prof. Ashby by Prof. W. H. Weston, Jr., of Harvard University early in 1925.

Sub-cultures on potato extract, bean, maize-meal, and quaker-oats agars developed no oospores, with the exception of a very few embedded in the surface plectenchyma on the last-named medium. The pure cultures showed a copious aerial mycelium, few sporangia, but chlamydospores in abundance. Sporangia were developed freely from fragments of young agar cultures after lying in water for a day, and discharged zoospores readily. Zoospore suspensions yielded prompt infections on the uninjured leaves of a thin-leaved tobacco plant. The spots enlarged rapidly without forming sporangia on their surfaces. Fragments from the margins of spots transferred to water yielded sporangia abundantly after one to two days. These sporangia resembled those of *P. parasitica*, the mean of fifty measurements being:—length 45·7 microns, breadth 32·5 microns, ratio 1 : 1·4. One hundred chlamydospores from a two months' old lima-bean agar culture gave a mean of 34·0 microns and a range of 21·6 to 57·6 microns.

Mixed cultures

P. nicotianae was grown in mixed culture with the same strains of *parasitica* and *faberi* used in the foregoing mixtures. In all of these cultures *P. nicotianae* was inoculated on the top half of the agar slants. In the case of the mixtures with the *faberi* strains, in some of the cultures oospores were freely produced, in others scantily, and in some not at all. The mixtures with the *parasitica* strains were more regular and tables G and H present a summary of these mixed cultures. Cultures Nos. 44

and 45 appeared to contain oospores of *P. nicotianae* alone ; culture No. 42 those of the *parasitica* strain alone, and the rest of the cultures oospores of both species. The inference may be drawn that the oospores of *P. nicotianae* have a mean of approximately 22 microns and a range of approximately from 18·0 to 25·0 microns.

All the oospores seen in the mixed cultures were very definitely of the amphigynous type. The oospores were described by Breda de Haan as of the paragynous type, but that was many years before the amphigynous form of development had been observed. Oospores do not appear to have been seen by the later investigators in the Dutch East Indies. These observations tend to indicate that the three fungi, *viz. P. nicotianae*, *P. palmivora*, and *P. faberi*, may all be strains or forms of one species.

TABLE G

nicotianae *and* parasitica *strains*

Serial No.	*nicotianae* in mixed culture with *parasitica* strain.	Medium and temp.	Age of culture in months.	Number of oospores measured.	Position on slant.	Mean in microns.	Standard error.	Range in microns.
41	I	Bean. Ice chest.	2	50	Apex.	20·46	·294	14·4—24·3
42	I	Bean. Room temp.	2	50	Middle.	17·76	·203	14·4—21·6
43	II	Bean. Ice chest.	1	50	Middle.	19·36	·236	16·2—23·4
44	II	Bean. Room temp.	2	50	Middle.	20·7	·219	18·0—23·4
45	III	Bean. Ice chest.	1½	50	Apex.	21·0	·242	18·0—23·4
46	III	Bean. Room temp.	2	50	Apex.	20·0	·227	16·8—23·4

TABLE H

Frequency arrays for nicotianae *and* parasitica *strains*

Serial Nos. Microns.	41	42	43	44	45	46	Totals.
Under 15	1	5	—	—	—	—	6
15—16·9	7	11	6	—	—	1	25
17—18·9	8	29	21	8	7	19	92
19—20·9	3	4	7	14	13	9	50
21—22·9	19	1	13	22	19	19	93
23—24·9	12	—	3	6	11	2	34
25—26·9	—	—	—	—	—	—	—
	50	50	50	50	50	50	300

SUMMARY

1. Three strains of *Phytophthora parasitica* Dastur have been grown in pure culture and the mean size and range of the oospores determined.

2. Three strains of *Phytophthora faberi* Maublanc have been grown in mixed cultures with each other and the mean size and range of oospores produced have been recorded.

3. The three *parasitica* strains have been grown in mixed culture with the three *faberi* strains and the sizes of the oospores produced have been recorded.

4. Evidence is obtained that each of the strains of *faberi* have developed oospores when grown in culture with homothallic *parasitica* strains.

5. It appears probable that all strains of *faberi* can be induced to develop oospores under certain conditions.

6. These findings present no support to the view that *P. faberi* is heterothallic ; direct evidence of heterothallism in the genus *Phytophthora* has not yet been recorded.

7. Mixed cultures of *parasitica* strains with *Phytophthora nicotianae* Br. de Haan have developed oospores which indicate a mean size of 22·0 microns and a range of 18·0 to 25·0 microns for the oospores of *nicotianae* ; all the oospores seen in these cultures were distinctly of the amphigynous type.

8. The theory is put forward that the development of oospores by strains or species of *Phytophthora* is due to the influence of environment on the rate of metabolism of the thallus.

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APPENDIX

Note on the stromatoid bodies found in the mixed cultures.

Stromatoid bodies were found in several of the mixed cultures and agree with those described and figured by Gadd. Two types were definitely noted, (*a*) large stromatoid bodies, and (*b*) small stromatoid bodies.

(*a*) Large stromatoid bodies. These are large compact bodies of apparently cellular structure and in all cases noted of a lighter or darker yellowish colour. These bodies bore the same relations to the oospores as described by Gadd (*loc. cit.*) The impression was that they increased in size by an increase in the number of cell units round the peripheral region of the bodies, and in number as the numbers of the oospores in the cultures increased. The cells of which these bodies are composed react as if of a granular proteid nature.

(*b*) Small stromatoid bodies. These bodies appeared to have the same structure as those figured by Gadd (*loc. cit.*, plate X, fig. 18), but no oospores were seen in close association with them. They were by no means so abundunt as the large stromatoid bodies and all those noted were hyaline. No connection was observed between these bodies and the large stromatoid bodies.

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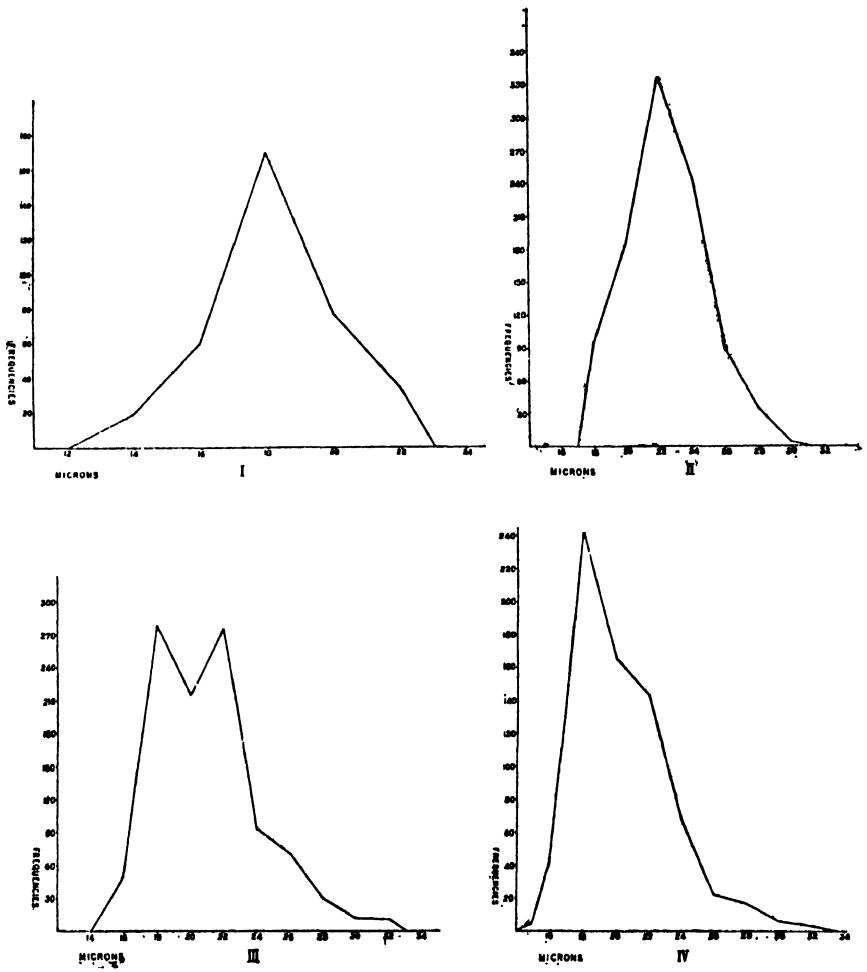

Plate XI

Graph I. *parasitica* strains in pure culture.
Total of frequencies (Table B).

Graph II. *faberi* strains in mixed culture with each other.
Total of frequencies (Table D).

Graph III. *parasitica* strains in mixed culture with the *faberi* strain from cacao. (Table F, total Nos. 10-17 and 30-40.)

Graph IV. *parasitica* strains in mixed culture with the *faberi* strain from coconut. (Table F, total Nos. 18-24).

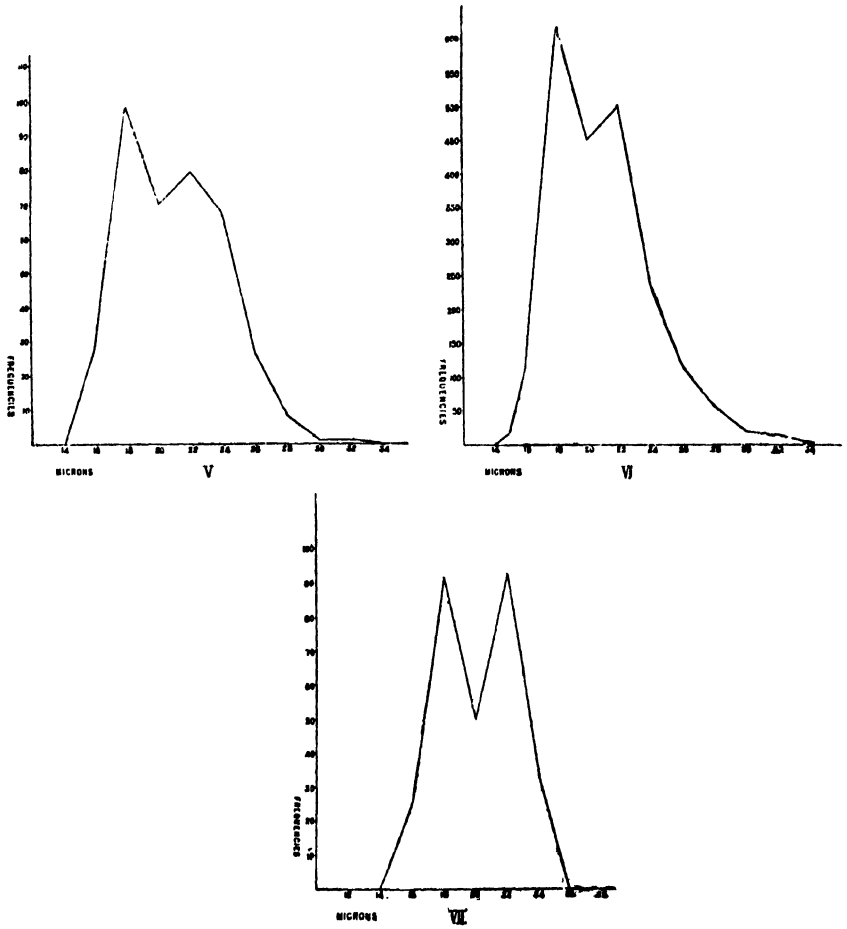

Plate XII

Graph V. *parasitica* strains in mixed culture with the *faberi* strain from cotton. (Table F, total Nos. 25-29).

Graph VI. Complete total of all the mixed cultures of *parasitica* strains with *faberi* strains. (Table F).

Graph VII. *nicotianae* in mixed culture with *parasitica* strains. (Table H).

Some investigations into conditions affecting the parasitism of Rhizoctonia solani Kühn

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INTRODUCTION

Diseases of herbaceous plants caused by *Rhizoctonia solani* have of late attracted attention in Ceylon. Gadd and Bertus (1) have recently completed investigations which have shown that, under favourable conditions, this fungus is capable of attacking a great variety of plants, particularly as seedlings. As the fungus lives in the soil it is difficult to treat affected areas satisfactorily. The experiments described below were carried out in the laboratory in order to study some of the physiological relations of host to parasite, so that practical recommendations for the control of the disease might be made from results obtained.

Various workers have studied *Rhizoctonia* diseases and have made suggestions with regard to the physiological conditions favouring the incidence of the disease. Briton-Jones (2), investigating "Sore-Shin" of cotton (due to *R. solani*) in Egypt, discussed conditions affecting the fungus in the field. He stated that increase in temperature of the soil lessened the incidence of "Sore-Shin," "not because of its direct inhibiting effect on the growth of the fungus but indirectly because of its accelerating effect on the growth of the seedling, and drying up of the upper layer of the soil, which has an inhibiting effect on the growth of the fungus." It would appear from his remarks that the more important influence is the moisture content of the surface layers of the soil. Again, in his general recommendations he emphasises the need of well-drained soil and of dry surface conditions. Gratz (3) working on wire-stem of cabbage caused by *R. solani* mentions experiments which indicate that a low temperature and a dry surface (obtained by covering the beds with a layer of sand ¼ inch thick) may reduce the incidence of the disease or delay it. Matz (4) says that plants producing abundant foliage are more liable to attack during suitable weather conditions, as the density of the

shade favours the growth of the fungus by conserving the humidity of the air.

From the writings of these and other workers it is obvious that soil-moisture and humidity of the air play an important part in the extent of damage caused by this fungus. Attention has been paid to these two conditions in the investigations discussed in this paper. The original intention was to study only the soil-moisture factor, but it was found during the course of the experiments that humidity of the atmosphere had a considerable bearing on the subject and in consequence a study was also made of that factor.

TECHNIQUE

In preliminary work to discover a suitable technique, experiments were carried out with dhal (*Cajanus indicus*) seeds grown in test-tubes containing soils of different water-content. This method was found to be unsatisfactory chiefly because of the relatively small amounts of soil used. Plugging of the test-tubes affected the humidity, and without plugs the loss by evaporation of a very little water considerably affected the percentage water-content. Cotton seeds were tried and were found to be of a more convenient size, and, as the disease of cotton due to *R. solani* is of economic importance, it was thought that results obtained would be more useful if directly applicable to such a crop. Therefore cotton seeds (Cambodia var.) were used in the experiments described below. Another point brought out by these preliminary experiments was the necessity for using an uniform soil and also, at any rate in the first instance, for the addition of water to the bottom layer of the soil rather than to the top. By doing this air-locks were obviated and a more natural form of wetted soil was obtained. Consequently the soil water was always added to the containing vessel before the dry soil.

The soil used throughout these experiments was prepared by heating garden soil in a hot air oven at 110°C. to 120°C. for about 3 hours and sifting it through a 40-mesh sieve. This gave a very fine and rather clayey soil. The heating sterilised the soil and prevented interference by other soil organisms. It was found that saturation of this soil was obtained by the addition of 35 per cent. of its weight of water. Beakers of 1 litre capacity were used and in these soil-moisture experiments water lost by evaporation was replaced each day by adding water through a glass tube ($\frac{1}{2}$ inch in diameter) which was placed in each beaker before the addition of soil. By this means water reached the surface by percolation and water-logging of the surface soil was prevented.

The beakers with their lengths of glass tubing were weighed. Soil to a depth of four inches was added to each and the weight obtained; this amounted to about 1,000 grammes. The soil was removed and water equivalent to 35 per cent. of the weight of the soil added to each beaker. The soil was then replaced and the tube in each beaker was arranged so that it stood vertically in the centre of the soil. The soil in five beakers was inoculated by placing pieces of sclerotia of *R. solani* from culture on maize-meal agar on the surface and all were covered with clock glasses. Germination of sclerotia was observed and hyphae were seen to grow over the surface of the soil. After five days the covers were removed and the required water-content of the soils was obtained by evaporation at laboratory temperature. Determination of the water-content of the soils was made by weighing. Once the correct water-content was obtained it was made up to standard each day by the addition of water. It was thought that a more equal infection of soils would be obtained by inoculating soils of equal water-content and allowing the excess water to evaporate than by inoculating soils containing different amounts of water.

After twenty days the water-content of the soils had reached the proposed quantities. Two sets of beakers of soil, one inoculated and one control, each contained 35, 30, 25, 20 and 15 per cent. water and the experiments were carried out with soils with these water-contents. It was found during these experiments that the loss of water by evaporation in one day was never equivalent to more than 2 per cent of the weight, of the soil; it was considerably less than this in the drier soils.

As has been stated above, cotton seed (Cambodia variety) was used. The seeds were de-linted by immersion in concentrated sulphuric acid for about 2 minutes, washed in several changes of water and presoaked over night. On the following day the seeds were germinated on damp blotting paper in glass boxes until the radicles had emerged $\frac{1}{4}$ to $\frac{1}{2}$ inch. At this stage they were planted.

Experiment I

Ten seeds were planted in each beaker at a standard depth of about 1 inch. By using germinated seed it was found possible to obtain a very large percentage of seedlings from the planted seed, and the error due to bad seed was thus minimised.

Psychometric readings were taken throughout the series of experiments and laboratory temperatures noted. Seeds planted in the soil inoculated with *R. solani* by means of sclerotia grew well and not a single case of positive infection was noted. This was thought to show that the infection of the soil was unsatisfactory and the experiment was closed. It was followed immediately by Experiment II which is described below.

Experiment II

When it was found that none of the cotton seedlings in the inoculated soil of Experiment I were infected, artificial inoculation with *R. solani* from a culture on maize-meal agar was made in the 5 inoculated beakers by placing small pieces of mycelium on the hypocotyls of the seedlings at soil level. All the beakers were then covered in order to aid infection. In three days all inoculated seedlings showed positive infection at the point of inoculation. At this stage all the seedlings in both control and inoculated beakers were cut into small pieces with flamed scissors and left on the surface of the soil for a week. In this time, *R. solani* grew abundantly in the inoculated beakers. After one week the remains of the seedlings were mulched into the surface of the soils of their respective beakers. It was considered that this material would supply the food necessary to keep *R. solani* in an active state and thus ensure that any lack of infection would be due, not to the absence of the parasite, but to other causes.

Seeds were prepared and germinated as before and were planted out in the beakers, ten seeds in each. The results of this planting are shown in Table I.

TABLE I

No. of beaker.	Water-content of soil.	No. of seeds.	Treatment.	After 5 days.		After 10 days.		Total number of diseased seedlings.
				No. of seedlings visible.	Seedlings diseased (visible).	No. of seedlings visible.	Seedlings diseased (visible).	
1	35 %	10	C	9	—	9	—	0
2	35 %	10	I	2	1	3	3	10
3	30 %	10	C	10	—	10	—	0
4	30 %	10	I	5	—	5	4	9
5	25 %	10	C	10	—	10	—	0
6	25 %	10	I	10	—	10	—	0
7	20 %	10	C	8	—	8	—	0
8	20 %	10	I	4	—	4	2	8
9	15 %	10	C	10	—	10	—	0
10	15 %	10	I	9	—	9	—	0

C = Control. I = Inoculated.

During the period of experiment the average humidity, as measured by wet and dry bulb thermometers, was 75·0 per cent. Readings were taken three times a day, at 9·30 a.m., noon and 4·30 p.m. The average temperature at 9·30 a.m. was 78·0° F. and the average maximum and

minimum temperatures 82·1°F. and 71·9°F. respectively. It will be seen from these figures that the temperature was fairly constant, while the humidity was high.

The most noticeable point in this experiment was the fact that failures of seeds to develop into seedlings were more numerous in inoculated pots Nos. 2, 4 and 8 than in the others. At the conclusion of the experiment seeds which had failed to develop were dug up. It was found that in the inoculated soils they had been attacked by the fungus before reaching the surface, except in the case of one seedling in beaker No. 10 which had been injured in planting. The two seeds which failed to develop in control beaker No. 7 had likewise been injured in planting. Bacterial contamination, probably due to bad seed, had killed one seedling in beaker No. 1 below the surface of the soil. The last column in table I gives the total number of seedlings killed by *R. solani* in each beaker. It was noticed also that the appearance of the seedlings showed a marked grading through the range. Those in the soil containing 35 per cent. water were not very robust and their weakness was attributed to the tendency to water-logging of soil with this water-content. The seedlings in the soils containing 30, 25 and 20 per cent. water were well developed, more particularly in the soil containing 25 per cent. water. The seedlings in the soil containing 15 per cent. water were poorly developed and obviously suffered from shortage of water.

No plants were affected in the soils containing respectively 25 and 15 per cent. of water. In the former case the absence of infection may have been due either to the fact that the fungus was not present in an active state or that the seedlings resisted infection. Seeing that seedlings in soil containing 20 per cent. water under similar conditions were heavily infected, it seems improbable that the water relation in the soil affected the fungus. All pots were treated similarly and *Rhizoctonia* was presumably present in the soil. It is difficult to understand why the fungus failed to attack the seedlings. Conditions may have been so favourable to growth that they were able to resist attack, but, in view of results obtained in later experiments, it seems more likely that the fungus was not in an active condition or that the soil was not thoroughly infected.

In the case of soil containing only 15 per cent. water, the surface soil became dry and the obvious explanation for the absence of infection is that insufficient water was present in the surface soil for active parasitism to take place.

The data obtained from this experiment, although indicating that the water-content of soil might have some influence on the parasitism of *R. solani*, were not conclusive. It was therefore decided to repeat the experiment.

Experiment III

The beakers from the previous experiment were covered with clock glasses and all the healthy seedlings in infected soil were re-infected with *R. solani* from culture. The seedlings in beakers Nos, 1, 3, 5, 7, 9 were all healthy and were cut up and mulched into the surface soil. Those in the other beakers all became heavily infected and were treated similarly. After 4 days a new set of seeds was prepared in a manner similar to the former. Then the radicles had emerged $\frac{1}{4}$-$\frac{1}{2}$ inch, the seedlings were planted, ten in each beaker, at a uniform depth. The water-contents of the beakers were made up to standard by the addition of water via the central tube to counteract loss by evaporation.

The results of the planting are summarized in Table II.

TABLE II

Beaker No.	Water-content of soil.	No. of seeds.	Treatment of soil.	After 5 days.		After 10 days.		After 15 days.		After 20 days.		Total number of diseased seedlings.
				Seedling visible.	No. diseased (visible).	Seedling visible.	No. diseased (visible).	Seedling visible.	No. diseased (visible).	Seedling visible.	No. diseased (visible).	
1	35 %	10	C	10	---	10	—	10	—	10	—	0
2	35 %	10	I	4	—	4	1	4	2	4	3	9
3	30 %	10	C	10	—	10*	—	10*	—	10*	—	0
4	30 %	10	I	10	—	10*	—	10*	3	10*	10	10
5	25 %	10	C	10	—	10	—	10	—	10	—	0
6	25 %	10	I	10	—	10	—	10	—	10	—	0
7	20 %	10	C	9	—	9*	—	9*	—	9*	—	0
8	20 %	10	I	9	—	9*	—	9*	7	9*	9	9
9	15 %	10	C	9	—	9	—	9	—	9	—	0
10	15 %	10	I	3	—	3	—	4	—	6	—	0

* Special treatment after 10 days as described below.
C = Control. I = Inoculated.

In discussing these results it will be better to consider them in two sections:—the results up to ten days after the beginning of the experiment and those after that time. It will be seen when considering the former section that of the seedlings which developed to the extent of being visible above the soil only one, in the wettest inoculated soil, was infected. The fact that only four seedlings developed in this pot out of the ten germinated seeds planted points to the possibility that the others were attacked by the fungus while still in the soil, and this was confirmed by examination at the conclusion of the experiment. In beaker No. 10 (containing 15 per cent. water) only three seedlings developed in 10 days,

whereas in beaker No. 9, 9 seedlings developed in the same time. All the seedlings which appeared in the soil of the former water content were obviously suffering from an insufficient water supply, and the fact that up to 20 days after planting new seedlings developed in pot No. 10 indicates that the absence of seedlings was due to lack of sufficient water rather than to infection by the fungus in the soil.

Apart from this, it was obvious that the results at the end of 10 days after planting were different from those obtained in the previous experiment. The only explanation of this difference was that the humidity of the air affected the results. Whereas the earlier experiment had been done in wet weather with an average humidity of 75 per cent., the conditions during the period of the experiment under review were different. The weather was fairly cool and dry and the average humidity was as low as 52·2 per cent. The average maximum and minimum temperatures were 83·0° F. and 71·1° F. respectively with an average temperature at 9·30 a.m. of 74·4° F. These temperatures approximated quite closely to those of the previous experiment and therefore differences could not be attributed to variation of the temperature factor. It was apparent that either the low humidity prevailing during the experiment had some bearing on the absence of infection or that the fungus was not actively present. In order to settle the latter question it was decided to cover two of the pairs of beakers and thereby increase the humidity. Beakers Nos. 3 and 4 containing soil with 30 per cent. water and Nos. 7 and 8 with 20 per cent. water were covered with bell-jars. The results are to be found in Table II. It is seen that in both of the covered beakers containing infected soil 100 per cent. positive infections resulted without any further inoculation with *Rhizoctonia*, whereas the controls under similar conditions remained healthy. The other beakers were left exposed to the atmospheric conditions during this time, and it will be seen from Table II that, whereas infection proceeded in the inoculated soil containing 35 per cent. water until one seedling only remained healthy, there was no infection in the inoculated soils containing either 25 or 15 per cent. water.

These results show that humidity of the air plays a part in the question of infection by *Rhizoctonia* as important as, if not more important than, that played by soil-moisture. It was obvious that, in order to throw some further light on the conditions affecting the infection of seedlings by *Rhizoctonia*, a further series of experiments with controlled humidity was necessary. These are described below.

CONSTANT HUMIDITY TRIALS

The first question which arose in connection with these experiments was that of obtaining a series of atmospheres of constant humidity

with the rather limited apparatus available. It was necessary that the method used should give readily a range of humidities which should not vary greatly and which could easily be standardised. It was realised very soon that the fact that the soil contained water and that the seedlings transpired at an early stage of development would lead to errors.

It was decided that a suitable method of obtaining atmospheres of constant humidity would be by the use of sulphuric acid of varying concentrations. Regnault (5) gives a table which shows the equilibrium pressure of aqueous vapour above dilute sulphuric acid, expressed as a percentage of the maximum pressure above pure water at the same temperature ; this is given in Table III.

TABLE III

	Grammes H_2SO_4 in 100 grammes mixture								
To C	84·48	73·13	64·47	57·65	52·13	43·75	37·69	33·10	24·26
10	1·25	5·46	13·09	20·57	33·05	48·73	63·03	70·05	84·15
20	0·89	4·90	12·89	21·44	33·30	48·84	62·28	70·82	83·27
30	0·71	4·72	12·87	22·23	33·87	49·44	62·11	70·22	82·78

It will be observed that the figures do not vary to any considerable extent with the temperature up to 30°C. An experiment was set up to determine whether, under the proposed experimental conditions, these figures could be adopted.

The apparatus was as in figure I. It consisted of a bell-jar (A) on a sheet of glass (B), the junction being sealed with plasticine (C). Sulphuric acid and wet and dry bulb thermometers (F) were placed under the bell-jar. The acid, of which 350 c.c was used at each determination, was placed in the lower part of a glass box (D); the water container for the wet bulb thermometer was a glass spirit lamp (E), the wick of which was used to keep the bulb of the thermometer wet. This form

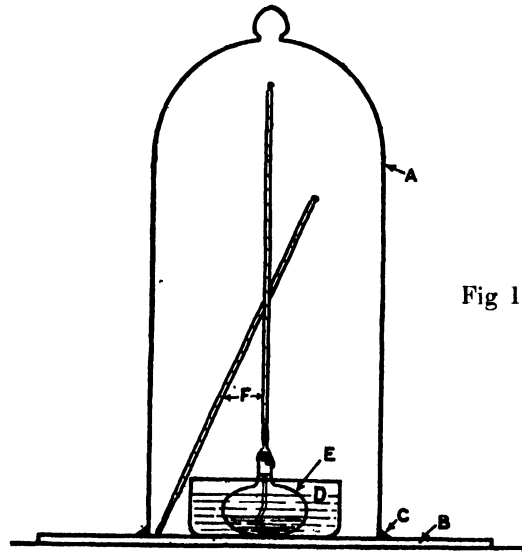

Fig 1.

of container prevented error from undue evaporation of the water. The psychometric thermometers were unfortunately too large to be used in this apparatus and smaller thermometers graduated in 1°C. (F) had to be used. The personal error in reading these was minimised by taking the average of a number of readings. The concentration of sulphuric acid was determined by means of a hydrometer before and after the series of readings and the mean concentration of acid considered to give the mean humidity. Domke's (6) tables for the density and specific gravity and hydrometer corrections for sulphuric acid were used throughout. Readings were taken four or five times a day over a period of three to four days, and it was found that the humidities calculated from these readings did not vary by more than 2 per cent. with one concentration of acid. The results obtained from 10 such humidity trials are given in Text fig. 2.

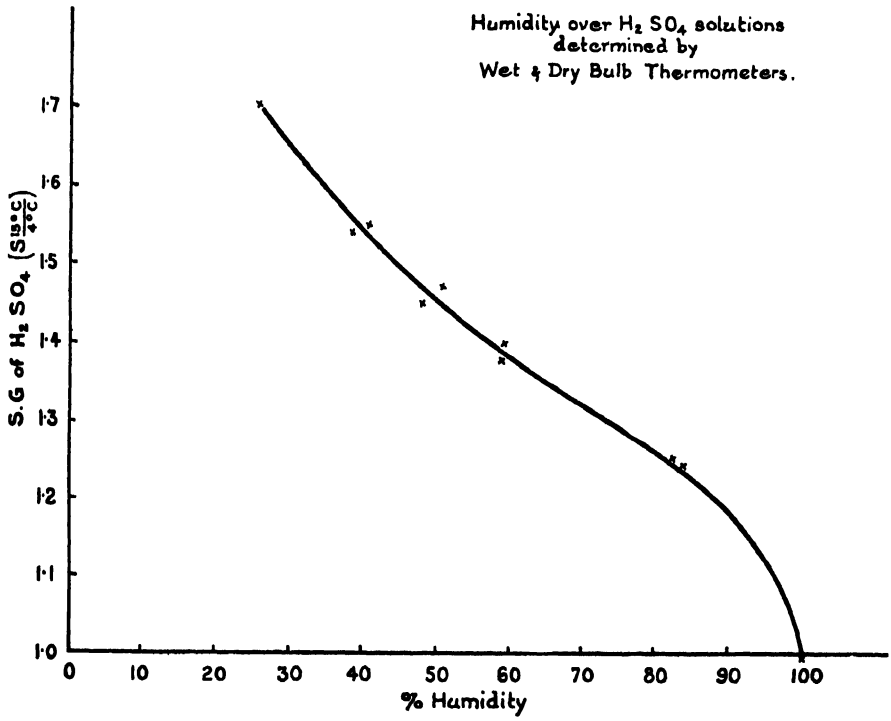

Fig. 2

Figure 2 shows that the results give a fair curve. Sources of error due to inaccuracies of the thermometers, hydrometers, etc., would account for the non-coincidence of the points with the curve.

These results differ considerably from those given in Regnault's table. As they were obtained under conditions very similar to those which would hold for the main series of experiments these results were preferred to those of Regnault. Consequently the humidities of the atmospheres in the series about to be described were determined by the method given above, but, nevertheless, in the results tabulated later both sets of figures are given.

Experiment IV

This experiment was carried out to determine it, in soils of the same water-content, humidity of the atmosphere would have any effect on the rate and extent of infection of cotton seedlings by *Rhizoctonia solani*. The soil used in this experiment was similar to that used in the previous experiments and was treated in the same way ; cotton seed of the same variety was used. Cigarette tins were used as containers. These, for the sake of convenience, were divided into groups of four and each group was brought to a standard weight by the addition of sheet tin.

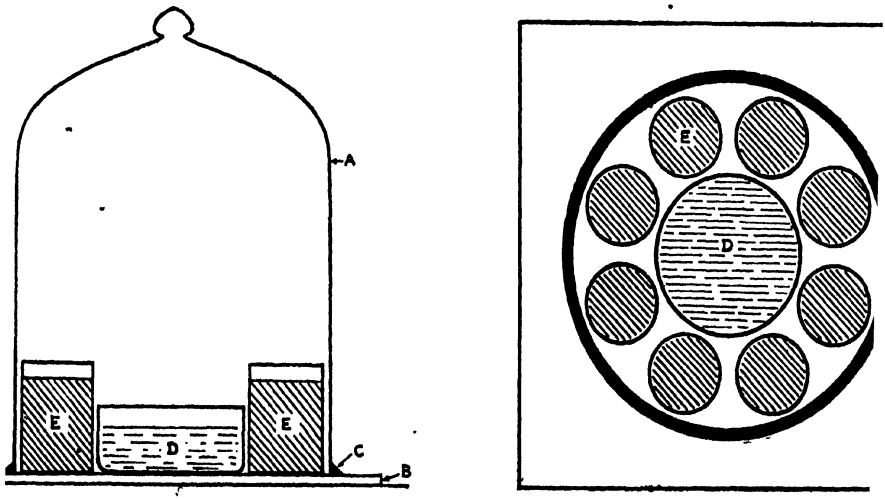

Fig. 3

62·5 grammes of water and 250 grammes of soil were added to each tin. The water-content of the soil (25 per cent.) was standard throughout the experiment. Cotton seeds were germinated as before and planted five in each tin. On the development of seedlings in a moist atmosphere, one-half of the number of prepared tins was inoculated with *Rhizoctonia solani* from a culture on maize-meal agar. All the inoculated plants

became heavily infected in 4 days. Every seedling, both control and inoculated, was cut up and mulched into the surface of the soil, as had been done in the previous experiments. After a fortnight's interval germinated seeds were planted, again five per tin, for the experiment proper. In each series, eight of these tins were used, four containing inoculated soil and four containing uninoculated soil as controls. Thus in each atmosphere of constant humidity there were twenty seeds in inoculated soil and twenty seeds as controls. The tins were arranged under bell-jars on sheets of glass as in Text fig. 3.

By preparing sulphuric acid of different concentrations five series were set up with atmospheres of approximately 40, 50, 60, 85 and 100 per cent. humidity respectively. The humidity figure for each atmosphere series was obtained by setting up a trial experiment, as described above, with a quantity of the same acid as was used for the series. Errors due to hydrometers and impurities of the acid were minimised by this means. 350 c.c. of acid were used under each bell-jar. Seeds were planted, and the experiment set up in one day. Bell-jars were removed on alternate days, the water-content of the soils brought up to 25 per cent. by addition of water, and the acids brought to their original specific gravity by the addition of concentrated sulphuric acid. It had been found by previous experiment that the humidity change due to the absorption of water by, and the consequent dilution of, the acid was in the case of the strongest acid less than 5 per cent. in two days.

The results of the experiment are summarized in Table IV.

TABLE IV

Series No.	Tin No.	Treatment.	Humidity determined by trial.	Relative Humidity as calculated from Regnault's Table.	After 2 days.		After 3 days.		After 4 days.		After 6 days.		After 8 days.	
					No. of seedlings.	No. of diseased.	No. of seedlings.	No. of diseased.	No. of seedlings.	No. of diseased.	No. of seedlings.	No. of diseased.	No. of seedlings.	No. of diseased.
I	1	Control	100%	100%	5	—	5	—	5	—	5	—	5	—
	2				5	—	5	—	5	—	5	—	5	—
	3				5	—	5	—	5	—	5	—	5	—
	4				5	—	5	—	5	—	5	—	5	—
	Total				20	—	20	—	20	—	20	—	20	—
	5	Inoculated	100%	100%	5	—	5	2	5	2	5	3	5	5
	6				3	—	4	1	4	2	4	4	4	4
	7				4	—	4	—	4	—	4	2	4	4
	8				4	—	5	—	5*	—	—	—	—	—
					16	—	18	3	18	4	13	9	13	13

* Tin No. 8 was discarded after four days.

Table IV—(*Contd.*)

Series No.	Tin No.	Treatment.	Humicity determined by trial.	Relative Humidity as calculated from Regnault's Table	After 2 days.		After 3 days.		After 4 days.		After 6 days.		After 8 days.	
					No. of seedlings.	No. of diseased.	No. of seedlings.	No. of diseased.	No. of seedlings.	No. of diseased.	No. of seedlings	No. of diseased.	No. of seedlings.	No. of diseased.
II	9	Control	84·7%	74%	5	—	5	—	5	—	5	—	5	—
	10				2	—	5	—	5	—	5	—	5	—
	11				3	—	4	—	4	—	4	—	4	—
	12				3	—	4	—	4	—	4	—	4	—
					13	—	18	—	18	—	18	—	18	—
	13	Inoculated	84·7%	74%	1	—	4	—	5	2	5	3	5	5
	14				1	—	4	1	4	3	4	4	4	4
	15				3	—	5	2	5	3	5	5	5	4
	16				5	—	5	—	5	1	5	3	5	5
					10	—	18	3	19	9	19	15	19	18
III	17	Control	59·6%	45%	4	—	5	—	5	—	5	—	5	—
	18				5	—	5	—	5	—	5	—	5	—
	19				4	—	5	—	5	—	5	—	5	—
	20				4	—	5	—	5	—	5	—	5	—
					17	—	20	—	20	—	20	—	20	—
	21	Inoculated	59·6%	45%	2	—	3	—	4	2	4	3	4	3
	22				4	—	4	1	4	2	4	2	4	2
	23				4	—	4	—	4	—	4	2	4	4
	24				5	—	5	—	5	2	5	5	5	5
					15	—	16	1	17	6	17	12	17	14
IV	25	Control	48·8%	30%	5	—	5	—	5	—	5	—	5	—
	26				5	—	5	—	5	—	5	—	5	—
	27				5	—	5	—	5	—	5	—	5	—
	28				5	—	5	—	5	—	5	—	5	—
					20	—	20	—	20	—	20	—	20	—
	29	Inoculated	48·8%	30%	5	—	5	—	5	—	5	—	5	1
	30				4	—	4	—	4	1	4	1	4	2
	31				5	—	5	1	5	2	5	2	5	3
	32				3	—	4	—	4	—	4	2	4	3
					17	—	18	1	18	3	18	5	18	9
V	33	Control	41·1%	14%	3	—	4	—	5	—	5	—	5	—
	34				3	—	4	—	4	—	4	—	4	—
	35				5	—	5	—	5	—	5	—	5	—
	36				4	—	4	—	5	—	5	—	5	—
					15	—	17	—	19	—	19	—	19	—
	37	Inoculated	41·1%	14%	4	—	4	—	5	—	5	1	5	1
	38				4	—	4	—	4	—	4	—	4	—
	39				1	—	2	—	4	—	4	2	4	2
	40				3	—	4	—	4	—	4	1	4	3
					12	—	14	—	17	—	17	4	17	6

Owing to accidental damage from acid one of the tins containing inoculated soil was discarded after four days.

In no case were any of the control seedlings diseased. In inoculated soil, 100, 94·8, 84·4, 50 and 28·4 per cent. of the seedlings were attacked in atmospheres of 100, 84·7, 54·6, 48·8 and 41·1 per cent. humidity respectively. It will be seen that there is a distinct diminution of infection with the decrease of humidity. Not only was the infection in the most humid series greatest in point of number of seedlings attacked, but also greater in extent on each seedling. In the most humid atmospheres whole plants became infected in a short time and the fungus developed a copious aerial growth of mycellium. The extent of attack showed a marked gradation through the series until in the driest atmosphere the infection was localised to a small discoloured area at soil level which did not in all cases kill the seedlings. The results obtained in this experiment show that, in a soil of constant water-content, the extent of infection of cotton seedlings in soil inoculated with *Rhizoctonia solani* varies directly with the humidity of the atmosphere.

GENERAL DISCUSSION

In the second experiment detailed above it was found that, in an atmosphere of high average humidity, seedlings in soils containing 35, 30 and 20 per cent. water and inoculated with *R. solani* became infected very heavily. Inoculated soils containing 25 and 15 per cent. water showed no infection. The fact that all the seedlings in inoculated soil containing 15 per cent. water were free from disease is explained by the dryness of the surface soil. The absence of infection in soil containing so little water can have no economic importance since the seedlings which grew were poor and weakly and would not have developed further without an increased water supply. The soil contained insufficient water for the fungus to be actively parasitic and, at the same time, contained too little for the seedlings to mature normally.

In the case of the inoculated soil of 25 per cent. water-content in which 100 per cent. healthy seedlings developed, this explanation cannot hold since, in a drier soil (with 20 per cent. water), under the same conditions, 80 per cent. of the seedlings were diseased either above or below the surface of the soil. Again, in Experiment IV, in which the soil used throughout contained 25 per cent. water, there was not a single series in which infection to a greater or less extent did not occur. It must be assumed, therefore, that the inoculation of the soil in this case had been unsuccessful and that the fungus was not present in an active condition. Neglecting this sample, it may be said that, when the soils tested contained such quantities of water that robust seedlings developed,

considerable infection took place under the conditions of the experiment, *i.e.* in a humid atmosphere.

Experiment III appears at first sight to have given results which are contradictory to those obtained from Experiment IV. In atmospheres which were drier than that which prevailed during Experiment III, a considerable infection of seedlings occurred in the later experiment. The absence of infection cannot be attributed to the absence of the fungus from the soil, since, after humid conditions were introduced, all the seedlings in the inoculated soils developed the disease without further inoculation. There is, however, a possible explanation. It will be remembered that in Experiments II and III the amount of soil used in each of the series was about 1,000 grammes. The depth of the soil was 4 inches. Water, in the first instance, was placed in the beakers before the addition of the dry soil. All subsequent addition of water, in order to replace that lost by evaporation, was made *via* the glass tubes which had been placed in the soil. Thus water was always introduced to the soil from the bottom and never from the surface. In an atmosphere of low humidity this method would tend to produce an uneven distribution of water in the soil and the surface layers would contain considerably less water than the lower layers of the soil. The depth of soil in Experiment IV was only 2½ inches and although water in the first instance was placed in the tins before the soil, it was found impracticable to make subsequent additions otherwise than to the surface soil. These factors tended to make the water distribution more equal in the latter experiment.

In Experiment III the surface soil in a comparatively dry atmosphere was dry and therefore the results obtained are not necessarily contradictory to those obtained in the other experiments. The soils in this experiment were similar to soil as it would be in a spell of dry weather in nature and from this it may be concluded that although the average water-content of soil may be relatively high, in a period of dry weather or in a period in which the humidity of the atmosphere is relatively low, infection of seedlings by *R. solani* present in soil would be slight. This conclusion and the results from the humidity experiment indicate that, if extremes of soil-moisture are excluded, the humidity of the air immediately above the soil plays a more important part in governing the parasitism of *R. solani* than does the average water-content of the soil. In nature, however, except in irrigated soils, the two factors are usually linked together.

PRACTICAL RECOMMENDATIONS

Recommendations for the control of diseases caused by *R. solani* based on the above experiments are such as will tend to reduce the humidity of the air in the plots. Shade in nurseries in which seedlings

liable to the disease are grown should be reduced to a minimum. Plants should be spaced as widely as is practicable in order to allow free passage of air between the plants. The position of a nursery should be chosen with the object of avoiding humid situations. Soil should be well drained so that the surface soil keeps as dry as possible without, of course, having a detrimental effect on the development of the plants. It has been seen in the above experiments that soils containing too much water not only favour the spread of the disease in inoculated soils but also produce inferior plants in disease-free soils.

The results of the experiments, however, show that where soil is infected with *R. solani* it is impossible to ensure freedom from the disease by altering conditions of humidity and soil moisture in the range in which plants can successfully be grown, under field conditions.

SUMMARY

Experiments (with cotton seedlings) are described above in which an attempt has been made to determine the effect on the parasitism of *Rhizoctonia solani* in inoculated soils of 1. varying soil-moisture in air during a humid period, 2. varying soil-moisture in air during a dry period, and 3. standard soil-moisture in atmospheres of varying humidity.

It has been found that, in the range of soil-moisture necessary for the successful development of cotton seedlings, a variation of water-content of the soils has little or no effect on the extent of infection of the seedlings. On the other hand, variations of the humidity of the atmosphere above the soil have an effect and results obtained indicate that infection increases with an increase of humidity.

Recommendations are made for the practical application of the results obtained.

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A Fusarium disease of Dadap (Erythrina lithosperma)

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WITH ONE PLATE

Specimens of a disease of Dadap were received from an estate in the Badulla district early in 1924, and similar cases have more recently been noted from an adjoining estate. From both estates it was reported that a number of trees were affected. Other cases of the disease have been received from other up-country estates, but on these the attack was confined to one or two trees only. The outbreak of the disease was associated with a spell of wet weather.

The area in which the disease occurred on the first-mentioned estate was in an exposed situation. The disease was first noticed when a number of trees failed to recover after lopping. It was then found that the lopped branches were dying back.

SYMPTOMS

The die-back may occur on trees before or after lopping, but more commonly the latter. Blisters up to 2 cm. long and 1 mm. in height appear on the cortex of branches. These are at first green-brown to olive in colour and have a water-soaked appearance. As the disease advances they dry out and become characteristic sunken areas of dead cortex, brown in colour. The cortex is shrivelled and easily separated from the wood. Developing blisters may fuse and cause a complete ringing of the stem with the result that the portion of the branch above dies off. In the case of lopped trees the die-back starts from the cut ends and proceeds more or less uniformly down the branch. The lenticels of the area affected develop pinkish pustules which are spores of a species of *Fusarium*. The typical blister-like appearance of affected

cortex is also apparent. As the die-back proceeds any young shoots which have developed previously from the newly affected area turn brown and eventually drop off. Cases have been observed of the die-back advancing down one side of the stem only. The demarcation of diseased and healthy tissue is clear, the edge of the affected cortex being somewhat raised, and darker in colour, and with a water-soaked appearance. An advanced case of an affected stem shows the brown shrivelled cortex above with a dark-brown edge adjacent to the freshly infected green cortex. Pustules of spores extrude from most of the lenticels of the diseased portions of the stem. The disease is most active in dull wet weather, and dry weather checks the spread and advance of the disease.

In early cases of attack the wood is healthy and only the tissue outside the cambium is affected. In advanced cases, however, the wood becomes discoloured and rots. This rot appears to be due to saprophytic organisms.

INOCULATION EXPERIMENTS

Portions of diseased Dadap stem obtained from an estate in the Badulla district were placed in a moist atmosphere in glass boxes. Examinations of these after a short time gave three fungi of which single spore cultures were made on nutrient agar. The fungi were a *Phoma*, and two species of *Fusarium*, one of which was present almost entirely in the microconidial stage.

The first inoculation experiment was carried out with these three fungi to determine which was pathogenic. Dadap cuttings were established and inoculations made on the stems of young shoots. The stems were sterilised by wiping with corrosive sublimate solution and washing with sterile distilled water. The inoculum used was a suspension of the spores of the fungi taken from cultures on maize-meal agar (twelve days old) in sterile distilled water. In the case of wounded inoculations the surface of the cortex was scratched with a sterile needle. The points of inoculation were covered with cotton wool wetted with sterile water and bound with paraffined tape, in order to prevent them from drying out. Two inoculations were made with each fungus, one wounded and one unwounded and two were treated similarly as a control.

The only inoculations which gave positive results were those made from culture of the second *Fusarium* strain, which was at first distinguished by the abundance of microconidia. In this case the wounded

stem showed typical symptoms after 4 days and the unwounded after 10 days.

The results are summarized in Table 1.

TABLE I

Inoculation No.	Fungus.	Treatment.	Observations.
1.	*Phoma*	Wounded.	Negative after 14 days.
2.	*Phoma*	Unwounded.	do.
3.	*Fusarium* 1	Wounded.	do.
4.	*Fusarium* 1	Unwounded.	do.
5.	*Fusarium* 2	Wounded.	Positive after 4 days—typical symptoms : lesion at point of inoculation.
6.	*Fusarium* 2	Unwounded.	Positive after 10 days, similar to above.
7.	Control	Wounded.	Negative.
8.	Control	Unwounded.	Negative.

Fusarium was re-isolated in pure culture from the stems which showed positive symptoms.

Although the number of inoculations made in the above experiment was not sufficient to conclude definitely that the strain of *Fusarium* No. 2 was the pathogen, it was sufficiently conclusive for the other two fungi to be discarded, and thenceforward work was only carried out with *Fusarium* No. 2.

Owing to the pressure of other work, it was found impossible to attempt to confirm the above by further inoculations for three months. Inoculations then made were unsuccessful, the fungus apparently having lost virulence in culture. Fresh diseased material was obtained and the same fungus again isolated. Single spore cultures on nutrient agar were prepared and inoculations made on the green stem, wounded and unwounded, and on the cut ends of lopped branches. The technique for the stem inoculations was as before. In the case of the lopped branches, branches $\frac{1}{2}$-$\frac{3}{4}$ inch in diameter were chosen and an area sterilised as before. The branches were cut off with a flamed knife at the place sterilised. Inoculum, consisting of a suspension of spores in sterile distilled water, was placed on the cut end together with a small piece

of sterile wet cotton wool to keep the point of inoculation moist, and the whole covered with a large test-tube, the lower end of which was plugged round with cotton wool. As controls, uninoculated stems and cut ends of branches treated as above, but with the inoculum replaced by sterile water, were used.

The paraffined tape was removed from the inoculated stems after 10 days, and it was found that all the five wounded controls were healthy. Of the six inoculated stems (unwounded) only one showed any sign of positive infection, there being a small discoloured patch of cortex ¼ inch in diameter at the point of inoculation. This failed to spread after removal of the tape, and dried out leaving a small brown sunken area on the stem.

Of the six inoculated stems (wounded) all showed positive infection. In the extreme case a discolouration of the whole of the surface of the stem was observed, extending 2-3 inches up and down the stem. The stem broke at this point after the removal of the tape. The extent of the discoloured area on the least affected branch was 1 inch long by ½ inch wide. When the tapes were removed three branches broke at the point of inoculation. The discoloured patches on the others failed to extend and dried out leaving lesions of varying extent. This drying out may be attributed to the dry weather prevailing at the time of the experiment.

Different symptoms were obtained from inoculations on the cut end of lopped branches. In each case the fungus developed strongly on the cut surface and a die-back of the inoculated branch occurred. Water-soaked blister-like swellings of the cortex, similar to those which appear on diseased branches in nature, developed on each of the inoculated stems. Pinkish pustules of spores extruded from the lenticels. The die-back spread rapidly so long as the tubes were left on the stems, preserving a moist atmosphere. On removing the tubes and exposing the inoculated stems to the dry conditions prevailing, the die-back ceased and drying out of the affected cortex took place, leaving the stems in a condition typical of dried diseased stems under natural conditions. *Fusarium* was obtained in pure culture from the extruding pustules of spores and was of the same species as that used for the inoculations. Of the six controls for the cut-end inoculation one was contaminated by bacteria and was discarded after 3 days, but the others remained healthy and failed to die back.

Results are summarized in the Table II.

TABLE II

Diseased material received 28.11.24. Pure cultures of *Fusarium* obtained same day : single spore isolations 2.12.24. Inoculations made 12.12.24.

Treatment.	No. of Inoculations.	Observations after 3 days.	Observations after 10 days.	Observations after 24 days.
1. Wounded control	5	—	All negative.	All negative.
2. Inoculated stem Unwounded.	6	—	1 with discoloured patch, 5-6 mm. diam.	5 negative 1 positive (slight.)
3. Inoculated stem Wounded.	6	—	6 positive.	6 positive (3 cases branch broken; 3 cases wound dried out and callus forming).
4. Inoculations on cut end of pruned branch.	6	Hyphae developed vigorously on all cut ends.	6 positive.	6 positive.
5. Controls : cut ends of lopped branches.	6	1 Bacterial (discarded) 5 negative.	5 negative.	5 negative.

From these results it is seen that the *Fusarium* isolated can cause a die-back and that it probably enters the host through a wound. The results suggest that entry is usually obtained through the cut-ends of branches of lopped trees, and also that atmospheric conditions must be favourable to the pathogen before it can develop strongly and that damp conditions are necessary for a serious outbreak of the disease.

THE FUNGUS

The external development of the fungus on the diseased Dadap is very scanty and is confined to the pustules of spores which extrude from the lenticels. At first these spores are mainly microconidia, followed later by macroconidia. The pustules are pinkish in colour. Pure cultures are obtained quite readily. The following notes are made on cultures originating in a single spore isolation, sub-cultures of which provided material for the successful inoculation experiment.

Studies of the fungus were made on several media and the characteristics of colour and aerial morphology compared. On no medium has a perfect stage been found, nor have sclerotia been observed. Chlamydospores are formed freely in old cultures on all media. Measurements both of microconidia and macroconidia were made of spores from cultures on various media at different ages ; in each case 100 spores were measured and the mean obtained.

No specific name has been applied to the fungus, but the following data are recorded for the purposes of identification. It is realised that the characters of the fungus do vary in culture, and that the dimensions of the spores vary with conditions and with the substratum on which the fungus is grown, but a study of the lengths of spores by biometric means has given certain comparable results which are discussed below.

The hyphae of the fungus, as found in culture, are fine, regular, septate, and hyaline when examined microscopically, and are 1-2μ in diameter. They branch freely and anastomoses have been observed, particularly of the germ-tubes of conidia in water and in old cultures. Aerial mycelium develops fairly strongly at first in culture, and large numbers of microconidia are formed in heads, usually terminally on rather short lateral hyphae. The mycelium at this stage is white in colour and later becomes dirty white. As the culture becomes older the aerial mycelium is less evident and in strong cultures producing sporodochia abundantly, little or no aerial mycelium is seen. Submerged hyphae are rather broader than the others and are sometimes irregularly swollen up to 5μ in diameter.

The microconidia (0-septate spores) are extremely variable in shape and size and are borne in typical *Cephalosporium* heads. They are the first spores to form and are found in abundance in cultures 3-4 days old. As mentioned above, they are formed terminally on rather short single conidiophores, which arise as lateral branches of the main hyphae and the heads are found singly and not in whorls or clusters. The majority of these conidia are more or less elliptical in shape, but spores may be pear-shaped, allantoid, or sub-fusoid. Examples are shown in Plate XIII fig. 2. They range from 5-11μ × 2-4μ in size, and the mean is 7·2μ × 3·1μ.

The macroconidia are borne in sporodochia which are up to 3 × 1.5mm. by 1 mm. high, in size. The sporodochia do not vary much in colour on different culture media. They are honey-brown, amber-brown, or yellow-brown in colour and when in "high culture" and supplied with plenty of moisture are smooth and shining rather like certain bacterial colonies. As the culture becomes old and dry the surface of the sporodochia becomes dull and the colour darkens somewhat. As the cultures age chlamydospores are formed by the conidia; then the sporodochia become discoloured and a dark-green tinge is observed, though the colour of the sporodochia is never completely changed. This change of colour begins to take place as chlamydospores are formed and it is assumed to be due to the formation of these. Chlamydospores are slightly darker when examined microscopically and no green colour is seen.

The sporophores of the macroconidia are verticillately branched, the branching usually being into threes (Plate XIII, fig. 3). Spores are produced terminally and in succession, but the spores drop off at once and do not, as in the case of microconidia, form a head.

The macroconidia are fairly uniform in shape throughout the range on the culture media examined, being straight or slightly curved with falcate tips (Plate XIII, fig. 1). The diameter of the spore is nearly uniform except at the tips. Spores are mostly 5-septate and the arithmetical mean of a number of mature spores on different culture media averages $54{\cdot}2 \times 4{\cdot}7\mu$.

Chlamydospores may be formed either on the submerged or on the aerial mycelium or from macroconidia, and are found in older cultures. They are smooth, thick-walled, intercalated or terminal on the mycelium, or produced before or after germination of conidia. They are either formed singly or in chains of two or three and occasionally four (Plate XIII, figs. 4-5). Singly, they are 8-10μ in diameter. Microscopically they appear to be slightly darker in colour than the other spores, but this may be due to the thickness of the wall. When produced in a conidium the contents of all the cells pass into any one cell which becomes swollen and thick-walled (Plate XIII, fig. 6). Sometimes one or more germ-tubes from one conidium anastomose with another and all the contents of both conidia produce one or two chlamydospores (Plate XIII, fig. 6). In some cases 5 or 6 conidia are joined together in this manner and produce a number of chlamydospores. Or again chlamydospores may be produced terminally on short germ-tubes (Plate XIII, fig. 6).

Chlamydospores were observed in a culture on steamed Dadap stem in a Roux tube, which had almost dried out, after 2 months. On other media chlamydospores are not produced till later. It is probable that the drying out of the culture hastened chlamydospore formation.

CULTURAL CHARACTERS OF THE FUSARIUM

The following are the characters of the fungus on different media. The cultures all originated from the single spore isolation culture and are of the same strain as the fungus used in the successful inoculation experiments.

The lengths of macroconidia were measured with an eye-piece micrometer and a 4 mm. objective. The draw-tube was so arranged that the side of one square of the eye-piece micrometer was equivalent to 18μ. For convenience, the spore-lengths were measured as a number of divisions, to the nearest tenth, rather than as a definite number of microns, and conversion was made afterwards. For this reason the points on the frequency polygons do not coincide in all cases with whole numbers of microns. Biometric calculations were based on Yule's (3) formulae.

Steamed Potato

The medium consisted of a cylinder of potato tuber cut out with a clean cork-borer, placed in a Roux tube and left in a steamer for 2 hours. After this period the tubes were sterilised for 20 minutes in an autoclave at 120°C.

After 2-3 days there was a vigorous growth of aerial mycelium at the point of inoculation and a copious production of microconidia. Later, amber-brown sporodochia of macroconidia were formed and the aerial mycelium was less in evidence. The sporodochia enlarged and in many cases fused, with the result that the whole surface of the potato was covered with what looked like a brown irregular slime, with a scanty aerial growth of grey-white mycelium. Microconidia were measured after 7 days. They ranged from 5·5 to 11μ in length and 2-4μ in breadth, with an average (of 100 spores) of 7·8μ × 3·2μ.

Macroconidia measured when the culture was 7 days old were 38-58μ × 4-5·5μ with an average (of 100 spores) of 49·2±·323μ × 4·3 μ. Spores from the same culture were measured after 21 days and the figures obtained were 45-59μ × 4-5·5μ with an average of 52·1±·188μ × 4·7μ. In Text fig. 1, are given frequency polygons of the spore-lengths of the spores measured at different ages.

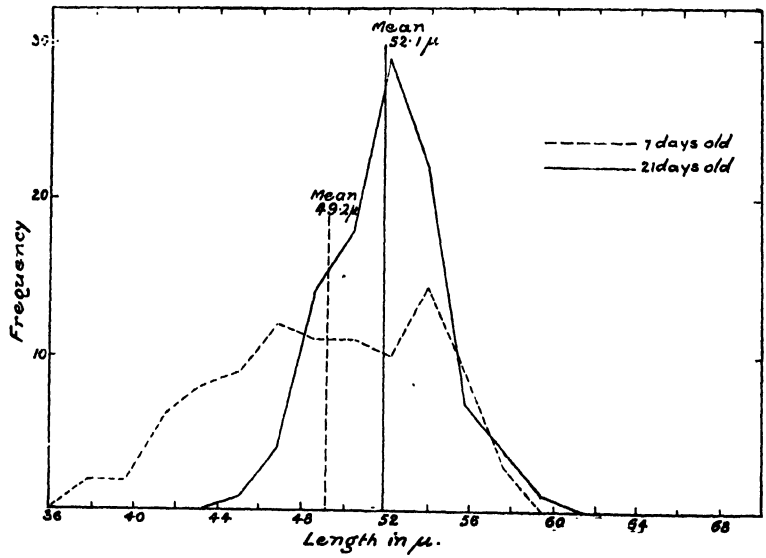

Fig. 1. Frequency distributions of spore-length of *Fusarium* grown on steamed potato.

The polygon of spore-lengths from measurements made after 7 days is much more irregular and the dispersion greater than that from measurements made after 21 days. The average spore-length after 7 days (49·2± ·323μ) is significantly less than that after 21 days (52·0±·188μ). The polygon of spore-lengths from the 7-day old culture shows that the proportion of short to long spores is about equal, and that there is no marked preponderance of spores of any particular length. On the other hand, the polygon of spore-lengths from the 21-day old culture shows a great preponderance of spores that are of approximately the same length as the mean. This may be explained by stating that whereas in the younger culture there are spores in all stages of development, in the older culture a number of them are approaching what is, for this medium and under these conditions, a maximum length.

The spores were 3-6 septate, 64 per cent. and 65 per cent. being 5-septate in cultures 7 and 21 days old respectively.

Steamed Rice

This medium was prepared from thoroughly washed rice. The rice was placed in tubes, with sufficient distilled water to cover it and heated in a steamer for 2 hours. The tubes were then plugged and sterilised in an autoclave for ½ hour at 120°C. One tube was not inoculated and was used as a control for colour and odour. Other tubes were inoculated and an examination after 10 days showed that relatively very few macroconidia were present. Aerial mycelium was fairly well developed, and microconidia were abundant. On no other medium were microconidia so abundantly produced as on steamed rice. The fungus caused a definite blue-violet discolouration of the rice. In old cultures the blue-violet discolouration is lost since the whole of the medium is covered with mycelium which masks the blue-violet colour; the resultant colour varies from white to grey. After 17 days amber-brown sporodochia were observed. Later, these became darker in colour. At no stage in the development of the fungus was any odour noticed. Microconidia taken from a culture 10 days old, ranged from 5-9μ × 2-4μ with a mean of 100 spores of 6·7μ × 3·1μ.

Macroconidia taken from a culture 10 days old measured 36-54μ × 4-6μ with an average (of 100 spores) of 45·1± ·403μ × 4·8μ. The spores were 3-7 septate, 52 per cent. being 4-septate. Spores from the same culture after 21 days were found to range from 45-61μ × 4-5·5μ with a mean of 53·0±·230μ × 4·7μ and were 3-7-septate with 43 and 53 per cent. 4-and 5-septate respectively. Another 100 spores were measured after 36 days. These were found to range from 43-61μ in length

with an average of 52·9±·214μ : (no width measurements were made of this group). Septation was 4-5 with 74 per cent. 5-septate. Text Fig. 2 shows the frequency polygons of the length of spores of these sets of measurements.

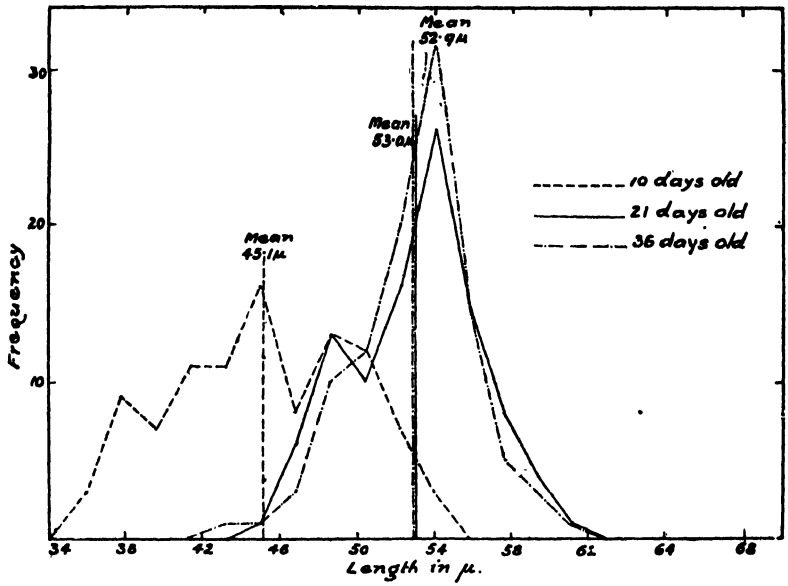

Fig. 2. Frequency distributions of spore-lengths of *Fusarium* grown on steamed rice.

The polygon of spore-lengths obtained from a culture 10 days old indicates that the spores are smaller than those from the older cultures. The distribution of spores is over a greater area and there is not, as in the case of the other polygons, a well defined " peak." These polygons again bear out the theory that the spores increase in length up to a certain maximum. The two polygons of spore-lengths from cultures after 21 and 36 days respectively are almost identical and the difference between the averages is not significant, mathematically. This means that spores from cultures on steamed rice under similar conditions do not vary in average length to any significant extent between the periods of 21 and 36 days.

Dadap Stem

This medium consisted of young green stems of Dadap (*Erythrina lithosperma*) of about ½" diameter and 1½" in length, washed thoroughly

in distilled water, and placed in prepared Roux tubes. These were then steamed for 2 hours and then sterilised in an autoclave for half an hour at 120°C. After inoculation there was a fair growth of white cottony aerial mycelium on the cut end (the point of inoculation) and later emerging from the leaf-scars. Microconidia were abundant after 4 days. Sporodochia were formed later and were honey-brown in colour and similar in appearance to those formed on other media. As the culture aged and dried out, the colour became darker, and, after two months, greenish streaks were observed in the sporodochia. This colour change was associated with the formation of chlamydospores.

The macroconidia were similar in shape to those on other cultures, and Text fig 3 shows the frequency polygons of the lengths of spores (one hundred in each case) measured after 4, 34, and 67 days. The septation of all the spores measured ranged from 3-6 and the majority of the spores were 5-septate. The measurements of macroconidia are given in Table III.

TABLE III

Age of culture.	Range of spore-length.	Mean spore-length.	Width range.	Mean width.
4 days	32—52μ	40·0±·365μ	4—5μ	4·25μ
34 days	47—67μ	56·0±·258μ	4—6μ	5·1 μ
67 days	41—61μ	54·0±·224μ	4—5μ	4·6 μ

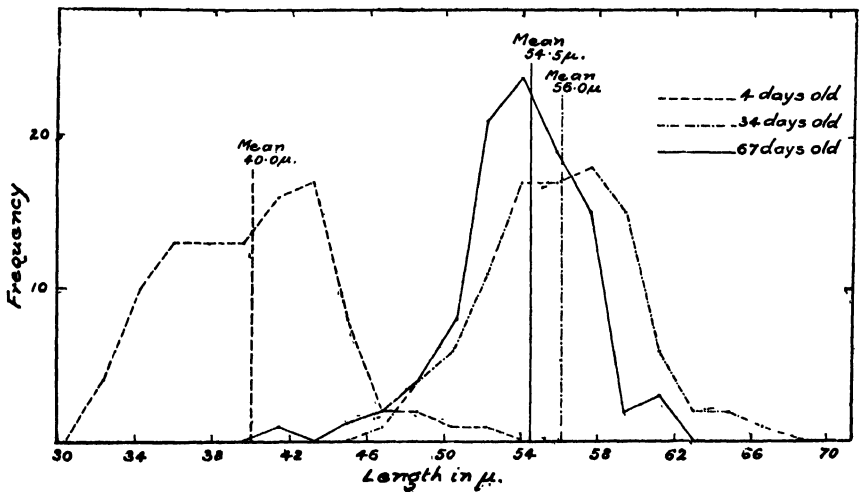

Fig. 3. Frequency distributions of spore-lengths of *Fusarium* grown on steamed Dadap stem.

It may be seen from the frequency polygons that the spores measured from cultures 4 days old are markedly shorter than those measured from cultures 34 and 67 days old, and that the largest spores are not so large as the average of the 34-day or 67-day measurements. It may be concluded from this that all of these spores are immature and have not attained their maximum length.

The mean length of spores from the 67-day old culture is significantly smaller than that of spores from the 34-day old culture. It would appear, therefore, that some factor or combination of factors comes into operation during this period which tends to reduce the mean length of spores.

It may be assumed from the above, that between 4 and 34 days there is a gradual increase in the mean length of spores until about the 34th. day, but that after that period there is a decrease in mean length, due to the operation of some factor or factors. Reference to these factors will be made later. It is obvious that there will be a number of days at or about the period of maximum growth, before any marked retrogression is apparent.

In measuring macroconidia from old cultures a large number of spores were found to have formed chlamydospores and the cells from which the protoplasm had been absorbed had collapsed. In examination of such cultures, only spores in the condition of the "norm" that is turgid and unaltered spores, were measured. It may be assumed that the majority of spores which produce chlamydospores are mature and at the point of maximum development. By ignoring full-grown spores which have formed chlamydospores, we are in effect removing a number of full-grown spores from the average sample. Consequently, the proportion of small and immature spores is relatively increased, with the result that the mean measurement of the sample is somewhat decreased. This fact would, to some extent, explain the smaller mean length of spores obtained from the 67-day old culture as compared with that of spores from the 34-day old culture.

Maize-meal Agar

This medium is prepared by boiling 25 grammes of ground maize in a little water for ½ hour, straining through muslin, making up to 250 cc. with water, adding 1½ per cent. agar and sterilising for ½ hour at 120°C. This gives a good starchy medium which favours the growth of most fungi.

Inoculated tubes give a rather sparse, evanescent growth of white cottony aerial mycelium, with a copious production of microconidia at first. After about 10 days amber-brown sporodochia are formed and these become abundant as the culture develops. The fungus dis-

colours the medium to a light grey-black colour. The microconidia are mostly oval and measure 6-9μ × 2-4μ. Four series of measurements were made of the macroconidia and a summary of these is given in Table IV.

TABLE IV

Age of culture.	Range of spore-length.	Range of spore-width.	Mean length.	Mean width.	Septation.
10 days	36—62μ	4—5·5μ	48·7±·304μ	4·7μ	4—6 (69% 5-septate)
41 days	45—66μ	4—5·5μ	56·8±·275μ	4·8μ	4—7 (55% 5-septate)
82 days (culture 1).	43—63μ	4—5·5μ	53·1±·224μ	4·9μ	4—7 (48% 5-septate)
82 days (culture 2).	45—61μ	4—5·5μ	53·4±·195μ	4·8μ	4—6 (61% 5-septate)
285 days	38—61μ	4—6 μ	48·3±·329μ	4·9μ	4—7 (55% 5-septate)

The measurements made after 82 days were from two cultures from the same parent culture which were grown under identical conditions throughout. These were made to determine whether *Fusarium* grown on the same medium under similar conditions of temperature moisture and nutrition would give spores of similar dimensions. It will be noticed that the measurements obtained from these cultures are very similar and that there is no significant difference between the results obtained.

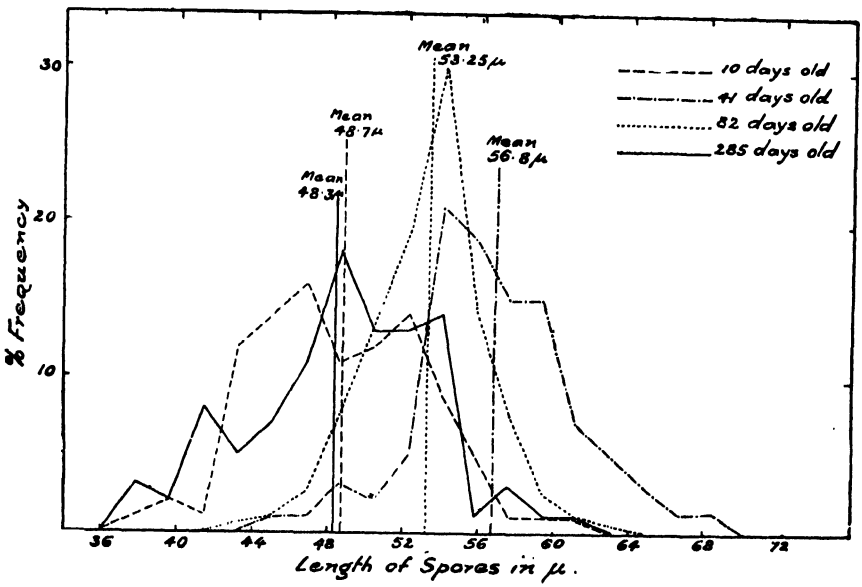

Fig. 4. Frequency distributions of spore-lengths of *Fusarium* grown on maize-meal agar.

The frequency polygons of the spore-lengths from cultures at different ages are given in Text fig. 4. These polygons indicate that the mean spore-lengths measured from a culture 10 days old are smaller than those from either the 41-day old culture or from the 82-day old cultures, but are larger than those from the 285-day old culture. The spores from the culture 41 days old are the largest, and those from the culture 82 days old are somewhat less, while after 285 days the average length of spores has diminished considerably. These measurements bear out what has been found on other media in that the average length of spores increases up to a certain maximum period and then decreases as the culture becomes older and other factors come into play.

GENERAL DISCUSSION OF THE FUSARIUM GROWN ON DIFFERENT MEDIA

Morphological characters

The general characters of the *Fusarium* on the media used are somewhat similar. There is in each case a somewhat evanescent appearance of white, or dirty-white, cottony aerial mycelium. This is accompanied at first, in all cases, by the copious production of the spores of the *Cephalosporium* stage, or microconidia. These vary in size and shape to such an extent that no systematic attempt has been made to compare their measurements. In all cases examined they were produced in a similar fashion, in heads, usually terminally on rather short lateral hyphae. The macroconidia are produced in sporodochia at rather a later stage and these sporodochia were found to be of a brown colour throughout the range of media. The macroconidia were observed to be similar in shape or rather, range of shapes, since they are somewhat variable on any one medium. Similar characters of variation in length of macroconidia have been observed on all media, but cultures of the same age, grown under similar conditions, on different media, do not necessarily produce spores with the same average length.

Studies of spore-lengths

In reading through literature on the subject of the genus *Fusarium* very few papers have been seen which have mentioned the application of biometric methods to the study of the spore-measurements. Most authors have been content to give the range of length of spores and but few mention the number of spores measured or the average length. It seems to have been assumed by most workers that the variability of the spores is so great that no significance can be attached to them. Brown (1) has shown that variations of a temporary and permanent

nature can be effected by drastic changes in media and conditions. While working on the *Fusarium* pathogenic on *Erythrina lithosperma* the author has found that the fungus, as is shown by a measure of the spore-length, shows significant differences on different media grown under similar conditions of light, temperature, and moisture, but at the same time has observed some constant characters with regard to relative variation of spore-length with age.

The first point to be emphasised is the fact that under similar conditions, on the same medium, and with cultures of the same age, the average length of spores was found to be within the range of probable error. Two sub-cultures on Maize-meal agar were made from one parent culture. After 82 days 100 spores from each culture were measured. The ranges of spore-lengths were 43-63μ in the first culture and 45-61μ in the second culture. The average spore-lengths were 53·1±·224μ and 53·4±·195μ with a difference of ·3±·436μ, which difference is within the range of the probable error. Thus the average spore-lengths of the two cultures may be taken as being identical. There is no reason to suppose that this should be otherwise with similar pairs of cultures at other ages and on other media.

The measurement of the spore-lengths of cultures at different ages has given results which are similar with each medium. It has been found that the average spore-length in similar cultures has increased up to a certain age, has kept constant for a time and has decreased after that period. That is to say, in any one culture the average spore-length will increase fairly rapidly up to a period when it is at its maximum for that medium under a given set of conditions, and that after that period, the average length of spores in a normal condition of turgidity, etc., will slowly decrease. It seems that there are several factors which can influence the average length of spores. Firstly, a number of mature conidia produce chlamydospores and consequently, as these are not measured, the mean spore-length of the sample is to some extent reduced. Secondly, there is the staling effect of the fungus on the substratum, as has been discussed by Brown (1) and Pratt (2). This would influence the size of the later-formed macroconidia. Thirdly, in old cultures there is a drying out of the culture medium which might also affect the size of macroconidia. Lastly, in old cultures in the presence of abundant moisture, germination of conidia has been observed with the production of secondary conidia, which when measured have been of less length than the primary conidia. All these factors would tend to reduce the mean spore-length obtained from average samples.

In Table V the evidence for the increase and decrease of spore-length with age is given.

TABLE V

Average spore-length on maize-meal agar.	Average spore-length on Steamed Dadap stem.	Average spore-length on Steamed Potato.	Average spore-length on Steamed Rice.
48·7±·304 μ (10 days).	39·96±.365 μ (4 days).	49·2±·323 μ (7 days).	45·1±·403 μ (10 days)
56·8±·275 μ (41 days).	56·0 ±·258 μ (34 days).	52·0±·188 μ (21 days).	53·0±·230 μ (21 days)
53·1±·224 μ (82 days).	54·0 ±·224 μ (67 days).	—	52·9±·214 μ (36 days)
53·4±·195 μ (82 days).	—	—	—
48·3±·329 μ (285 days).	—	—	—

It will be seen from this table that there is no significant difference between the average spore-lengths of the *Fusa.ium* on steamed rice measured after 21 and 36 days. This means that with cultures grown on steamed rice under similar conditions, the probability is that the average spore-length will be approximately equal whether measured after 21 days or 36 days, and it is natural to assume that it will be the same during the period, between 21 and 36 days.

On steamed Dadap stem, the difference between the average length of spores measured after 34 and 67 days is 2·0±·342μ. This difference is significant. (A significant difference is defined as a difference which is at least five times as great as the probable error of that difference, which error is obtained by taking the square root of the sum of the squares of the probable errors of the two results). Therefore, in this case it can be said that the probability is that, under similar conditions, the average spore-length measured from cultures on Dadap stem after 34 days will be greater than that measured after 67 days. Presumably, at 67 days other factors mentioned above have come into play and the average spore-length has begun to decrease. Thus, at this age, the culture has passed the period of optimum growth, as judged by measurement of spore-lengths.

The differences between the mean spore-length of the 41-day old culture on maize-meal agar and the mean spore-lengths of the two 82 day old cultures on this medium are 3·7±·355μ and 3·5±·337μ respectively. Both differences are significant and indicate that the average length of spores from a culture on maize-meal agar measured after 82 days will be less than that of spores from a culture 41 days old. Similarly

it can be demonstrated that the average length of spores from a culture 285 days old will be considerably less than that of spores from a culture 82 days old. These facts seem to justify the assumption that the average length of spores decreases after the period of maximum or optimum development which ranges around 41 days for this medium.

The measurements from cultures up to 10 days old are for each culture medium significantly less than the average lengths of spores from cultures over 20 days old. The difference in each case is marked and shows that the average spore-length on any one medium increases quite rapidly up to a point of optimum development, given uniform conditions.

The points discussed above have led the following conclusions. The development of spores, as measured by the average spore-length, of this *Fusarium* is comparable on different media, and consists of a fairly rapid increase in length up to a certain period of optimum development which continues for some time. After this period other factors enumerated above come into play and the average length of spores consequently diminishes.

From the above it would appear that within the period of, say, from 20-50 days after inoculation the average spore-length is approximately the same on any one medium provided that conditions are kept approximately constant. It should, therefore, be possible to compare the biometric constants of the spore-lengths of the fungus on different media measured at any time during that period. The comparison should show whether, other things being approximately equal, the measurement of spore-lengths is or is not the same on different media. In Table VI are given the biometric constants of the spore-lengths of the fungus measured during this "optimum" period.

TABLE VI

Culture Medium.	Age of Culture.	Mean μ.	Median μ.	Mode μ.	Standard Deviation μ.	Skewness.
Maize-meal Agar.	41 days.	56·75±·275	57·21	58·31	4·10±·196	—·336±·096
Steamed Potato.	21 days.	52·11±·188	52·11	52·11	2·79±·133	0±·096
Steamed Rice.	21 days.	52·97±·230	53·37	54·16	3·42±·163	—·348±·096
Dadap.	34 days.	56·02±·258	56·07	56·18	3·83±·183	—·423±·096

The difference between the mean lengths of spores measured from cultures on the different media is significant and is greater than the difference which would normally be expected through errors in sampling. Thus it can be said that according to the results obtained from these examinations, the length of spores of this *Fusarium* is not the same at

the period of "optimum" development on the four different media used. Other conditions were in each case very favourable for the growth of the fungus, the laboratory temperature range during the whole period being 22°-28°C., the cultures saturated with moisture up to and during the period of optimum growth, and the light being the same for all. It is, therefore, assumed that any difference observed in the length of spores of the fungus during this period may be attributed to the difference of medium.

CONTROL

Dadap is commonly used at "mid-country" elevations as a green manure for tea. The *Fusarium* disease is most serious during a period of wet weather, immediately after lopping. The inoculation experiments show that the *Fusarium* is commonly a wound parasite, and given suitable conditions, it may cause a serious die-back disease from the cut ends of pruned branches. Dadap is not of sufficient economic importance to warrant expensive treatment for a sporadic disease of this nature. The best method of prevention is to avoid lopping Dadap in wet weather and if practicable, to tar the cut ends. When the disease appears the affected branches should be cut back to healthy tissue as early as possible, and the diseased tissue burned. The fungus which causes this disease produces an abundance of air-borne spores, so that given suitable conditions it might easily become epidemic. The burning of the diseased tissues as early as possible would minimise the risk of such an occurrence.

SUMMARY

An investigation of a die-back disease of Dadap (*Erythrina lithosperma*) has been made. The die-back occurs particularly after lopping in wet weather.

A species of *Fusarium* obtained from the diseased tissue has been proved by inoculation experiments to be the pathogen.

A study of the spore-lengths of the fungus grown on different media under similar conditions has been made and the results compared biometrically.

An analysis of the figures obtained shows that, while the fungus (as judged by the average length of spores) varies on different media, there is for each medium examined a period of "adolescence," a period of "optimum growth," and after this a period of "retrogression." The factors influencing these periods are discussed.

For control, lopping should be avoided in wet weather, and affected tissue should be removed and burned.

My thanks are due to Dr. C. H. Gadd, of this Department, for his kindly criticism and advice.

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2. Pratt, C. A. General and chemical investigation of staling by *Fusarium*—Ann. Bot. XXXVII 155, pp.563-595.
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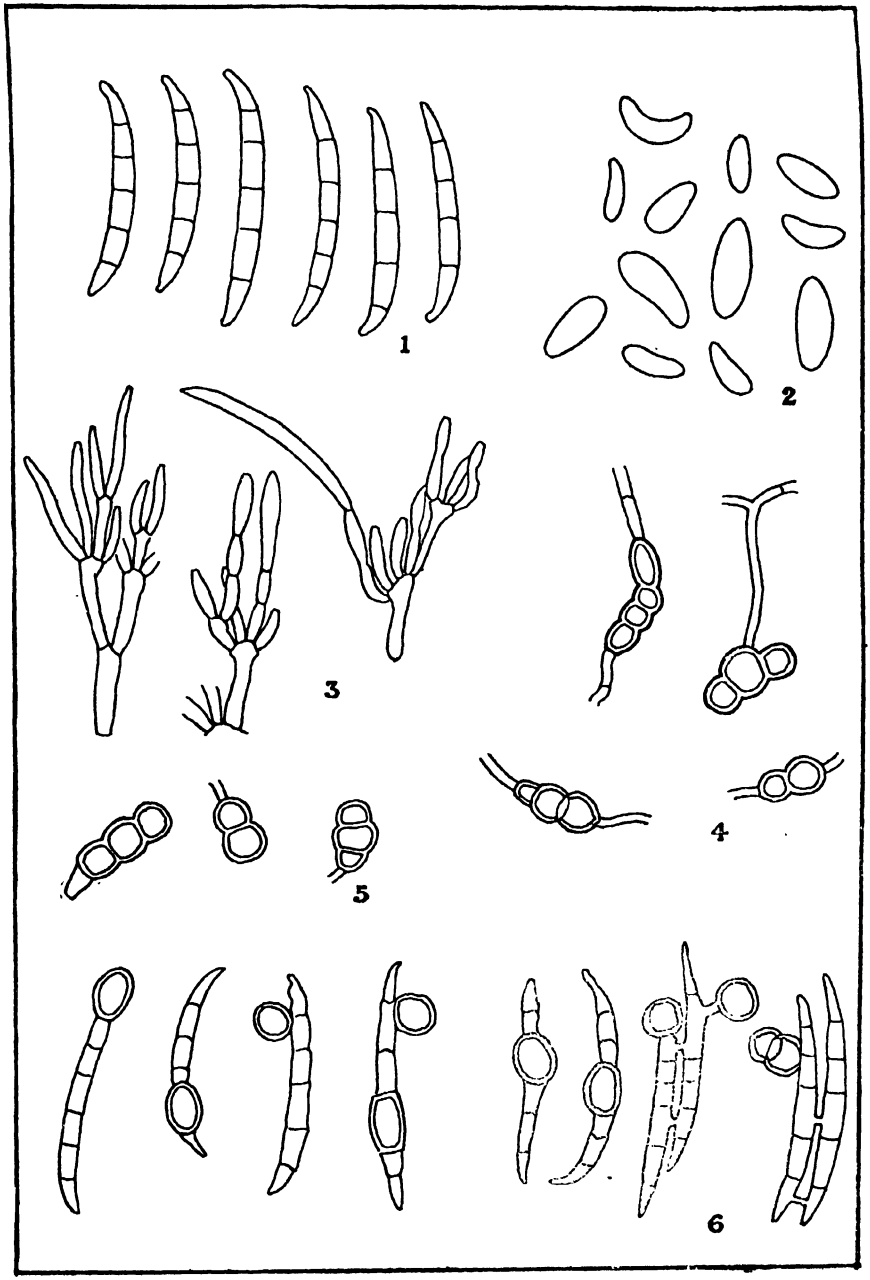
EXPLANATION OF PLATE XIII

1. Types of macroconidia from culture × 550.
2. Types of microconidia from culture × 1400.
3. Conidiophores × 550.
4. Chlamydospores on submerged mycelium in culture × 550.
5. Chlamydospores on aerial mycelium × 550.
6. Chlamydospores developed from conidia × 550.

(Received for publication December, 1925.)



Fusarium Disease of Dadap.

Fruit Diseases of Chillies

BY

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WITH TWO PLATES

In 1923 a disease was reported on chilli fruits in the plots of the Economic Botanist at Peradeniya. On examination of a large number of diseased fruits three fungi were found, a *Vermicularia*, a *Colletotrichum* and a *Gloeosporium*. Very often two of these fungi were found on the same fruit. With the aid of a hand lens the *Vermicularia* could be easily distinguished from the *Gloeosporium* by the presence of bristly hairs in the fructification; similarly the *Colletotrichum* could sometimes be distinguished from the *Gloeosporium*. It is difficult to distinguish the *Colletotrichum* from the *Vermicularia* because both possess setae, although the setae of the *Vermicularia* are usually more abundant and conspicuous. As these fungi were found associated, it was suspected that they might have a common perfect stage. Examination of many diseased fruits did not show the presence of a perfect stage on any of them, although they were plucked, placed in a moist chamber and examined from time to time. Individual fruits were selected which had only one fungus present and pure cultures made with single spores in order to find out if possible if a common perfect stage would develop in culture.

Later, in a plot of chillies growing near the laboratory diseased fruits were picked which had a *Colletotrichum* on them and also a perithecial fungus. Single conidia and ascospores were taken into culture and inoculations made on fruits in the field and under laboratory conditions, to prove that the perithecial fungus found in nature is the perfect stage of the *Colletotrichum*.

In the early stages the diseases caused by these fungi cannot be distinguished as their symptoms are similar. The *Vermicularia* does more damage than the others, as it spreads to the branches via the fruit-stalks and kills them back gradually.

As no fresh outbreaks of fruit disease have been reported and as chilli is not grown on an extensive scale, it is not possible to estimate the amount of loss caused by fruit disease in Ceylon.

COLLETOTRICHUM NIGRUM E. & HALST. PERITHECIAL STRAIN

In a plot of chillies growing near the laboratory diseased fruits were found which bore fructifications of a *Colletotrichum* together with the perithecial stage of an ascogenous fungus under such conditions that it appeared probable that the ascomycete was the perfect stage of the *Colletotrichum*.

Both fungi were taken into pure culture and grown in distilled water, Raulin neutral medium, and maize-meal agar in order to prove by cultural study and inoculation that the perithecial stage found in nature on the fruit is the perfect stage of the *Colletotrichum*. Single spore cultures were readily obtained from the conidia of the *Colletotrichum* and the ascospores of the ascomycete by the plating method.

Inoculations were made from pure cultures of both fungi on chilli fruits in the field, plucked fruits in sterile tubes, and on potato slab and chilli fruits sterilised in Roux tubes.

The disease in nature. The first symptom of the disease is a slight dirty brown discolouration on the ripening fruit. This discolouration spreads rapidly, becomes darker and the whole surface of the fruit may appear sodden. In some cases the fruit drops to the ground in a rotten condition; in others it remains attached to the bush, and shrivels up, but does not fall till quite dry. The fruit stalk may become infected, but usually the disease does not spread to other parts of the plant. Small black points appear early on the diseased fruits; these are the fructifications or fruiting bodies of the fungus which cause the disease. At the time the fruit falls, it is usually covered by fruiting bodies.

A green fruit about half-grown, on a bush in the open, showed a slight discolouration light brown in colour, near the base of the fruit stalk. This discolouration extended a few millimetres and fructifications were formed over the discoloured area and extended over the apparently healthy, green portion in the form of small black points, single or massed together. On examination the fungus was found to be a *Colletotrichum*. Later, small greyish bodies were also formed which turned black. These were also fructifications of the same fungus. The fruit was picked and placed in a sterile petri-dish and when examined ten days later perithecia had developed. On examining more diseased fruits on the same bush, both perithecia and acervuli were found. The perithecia on the different fruits were identical.

Pieces of the diseased fruits were embedded and microtomed for examination. The acervuli are scattered or gregarious, black, erumpent, saucer or bowl shaped, up to 0·65 mm. diameter. The conidiophores are hyaline, septate, sometimes branched, rarely non-septate, up to 70 μ long and 3-4 μ diameter. The setae are dark brown, lighter coloured at the tip, septate, rigid, straight or slightly curved, up to 160μ long, 4-5μ diameter in the middle, and up to 8μ diameter at the base. The conidia are unicellular, hyaline, cylindrical, straight or slightly curved, pale pink in mass, 12-23 × 4-7μ, with a mean (50 spores) of 18 × 5·4μ.

The perithecia are formed on a loose indefinite stroma of light-brown interwoven hyphae. They vary in shape from globose to flask-shaped, are dark-brown in colour, scattered or clustered, up to 245 μ high and 184μ diameter. The yellow-brown parenchymatous wall varies in thickness in different perithecia from 15 to 35μ. The wall at the papilla (when present) is of a lighter colour and is thinner than at other parts of the perithecium. Paraphyses are lacking. The asci are cylindrical or clavate usually with a short stalk expanded at the base, and measure 42-65 × 8-13μ (Plate XV, figs. 5, 6, 7). The ascospores, 8 in number, are roughly arranged in two rows within the ascus. They are unicellular, curved, hyaline or pale brown, 12-21 × 5-9μ with a mean (50 spores) of 17·5 × 6·2μ.

The following examples illustrate the variation in shape and size of the perithecia :—

(*a*) Globose with conical apex (papilla) ; height 200μ, diameter 184μ; wall 35μ thick ; at base slightly thicker and at apex about 18μ (Plate XV, fig.1).

(*b*) Conoid : height 175μ diameter 140μ, wall 35μ thick ; at base slightly thicker, at apex 18μ.

(*c*) Flask-shaped, fused with another perithecium ; height 245μ, diameter 122μ, wall about 18μ thick (Plate XV. fig. 2).

(*d*) Conoid ; height 175μ, diameter 105μ, wall 25μ thick.

(*e*) Conoid ; height 140μ, diameter 100μ, wall 15μ thick. This perithecium is fused with an acervulus with a diameter at base of about 100μ, (Plate XV, fig.4).

(*f*) Globose with conical apex ; height 140μ, diameter 150μ; wall 20μ thick.

Cultures from single conidia

Germination in water.—In water, the conidia, whether taken from the fruit in nature or from cultures, germinate in four to seven hours. The germ-tubes may form intercalary chlamydospores (Plate XIV, fig. 4)

or terminal appressoria (Plate XIV, figs. 1, 2). The appressoria are irregular dark-brown bodies, thick-walled and with granular contents, 6-13 × 5-8μ. The chlamydospores are lighter brown in colour, their contents more homogeneous, and their shape more regular. Appressoria do not develop on all the germ-tubes, and consequently cannot be considered a definite character. Growth may occur from an appressorium and the hyphae may again terminate in another appressorium (Plate XIV, fig. 3).

Raulin neutral medium.—Single conidia which had germinated in a petri-dish after plating were picked out and transferred to Raulin medium slants.

The mycelium was at first white, then greenish, then light olive grey. At this stage small black bodies and pink pustules or spores were scattered over the surface. By the tenth day the mycelium formed a purplish grey felt, with small greyish or blackish bodies scattered over it; and by the fourteenth day, black pulvinate masses, up to 4 mm. in diameter, and more or less regular, together with erect sclerotium-like bodies, are found on the felted layer.

Microscopic examination.—A stroma varying in depth from 0·15 mm. to 0·23 mm. is formed on the culture medium. On this stroma a loose film of mycelium is present. The acervuli are pulvinate, pseudoparenchymatous masses, made up of interlaced, closely septate, brown mycelium, situated on the stroma, underneath the loose film of mycelium. They occur singly or may stretch indefinitely over the surface of the stroma, and are black in mass, but produce pink pustules of spores. The setae arise from the pseudoparenchymatous base, and are dark-brown, septate, rigid, straight or geniculate, acute and paler at the apex, up to 210μ long and 3 to 5μ diameter; they vary in number in different acervuli, from few to many. The conidiophores arise from the same base as the setae and are simple, hyaline or tinted-brown, non-septate or septate, straight, or irregularly swollen, up to 50μ long and from 3 to 5μ diameter. Very often the lower cells of a septate conidiophore are light-brown. The conidia are hyaline, unicellular, straight or slightly curved, cylindric, pale pink in mass, 14-21 × 4-7μ, with a mean (50 spores) of 17·1 × 5·5μ. The black pulvinate masses and the erect sclerotium-like bodies are simply masses made up of numerous perithecia, some distinct, some fused together, and often with stromata containing numerous perithecia or loculi. These masses usually grow upwards from the stroma on the culture medium, raising the loose film of mycelium on the surface, but sometimes they extend irregularly downwards into the stroma of the culture medium or into the culture medium itself. The perithecia of which these masses are composed may be spherical, globose, oval, or

rectangular oval. The thickness of the wall in different perithecia varies up to 30μ. The asci which are plentifully developed in these perithecia and loculi, are clavate or cylindrical 42-55 × 8-13μ, with a short stalk up to 10μ long and 3μ diameter, expanded at the base, or sometimes sessile. The ascospores are hyaline, unicellular, slightly curved, elliptic, 13-23 × 4-8μ, with a mean (50 spores) of 17·3 × 5·8μ.

Details are here given of a typical pulvinate mass and an erect sclerotium-like body.

(A) *Pulvinate mass.* Greatest width 2·3 mm.; greatest height 1·8 mm. The whole body is covered with a loose film of mycelium. Shape and dimensions of a few of the perithecia in the mass are given below.—

(*a*) Globose, width 200μ, height 175μ, wall 20μ thick.
(*b*) Spherical, diameter 140μ, wall 15μ thick.
(*c*) Vertically oval, height 175μ, width 135μ, wall 17μ thick.
(*d*) Spherical, diameter 120μ, wall 25μ thick.

This pulvinate mass in addition to the numerous perithecia grouped together contains a stroma containing numerous loculi (perithecia) filled with asci. The stroma is almost spherical in shape with a diameter of about 0·46 mm. It has a distinct wall 30μ thick.

(B) *Erect sclerotium-like body.* Greatest height 1·5 mm., width 1·15 mm. Shape and dimensions of a few of the perithecia are here given.

(*a*) Spherical, diameter 210μ, wall 25μ thick.
(*b*) Spherical, diameter 140μ, wall 20μ thick.
(*c*) Oval, height 140μ, width 200μ, wall 20μ thick.
(*d*) Rectangular oval, height 135μ, width 250μ, wall 30μ thick.

Maize-meal agar. The agar slants were inoculated with a pure culture. The growth on this medium was similar to that on Raulin neutral agar, but not so luxuriant.

Microscopic examination. The characters of the perithecia and stromata are similar to those on Raulin neutral agar. The conidia measure 12-21 × 4-7μ with a mean (50 spores) of 16·5 × 5·3μ; the conidiophores are up to 52μ long and 4 μ diameter; the setae up to 200μ long and up to 6μ diameter. The asci are 38-60 × 7-11μ and the ascospores 14-20 × 5-7μ with a mean (50 spores) of 17·1 × 5·84μ. Perithecia are also developed in this culture medium from old acervuli. In Plate XV, fig. 6, a section of an old acervulus is shown. From the base of this acervulus, *i.e.* from the pseudoparenchymatous layer, setae are produced. The basal cells also produce brown hyphae which grow out and radiate in strands in the shape of an open fan and terminate in perithecia which may be single or fused together. The perithecia

are similar to those found in the pulvinate masses. The thickness of the walls in the different perithecia varies up to 20μ and the diameter or greatest length up to 200μ.

Cultures from single ascospores

Germination in water. The ascospores germinate in water in about the same time as the conidia. As in the case of the latter the germ-tubes may form intercalary chlamydospores or terminal appressoria (Plate XIV, figs. 12, 13, 14). A spore may bud off a secondary condium from one end and produce a hypha at the other end (Plate XIV, fig. 15). The secondary conidia are almost spherical or fusoid in shape and measure 8-11 × 5-7μ. In old cultures, conidia similar in dimensions to those of the *Colletotrichum* are produced at the end of branched germ-tubes (Plate XIV, fig. 10).

Raulin neutral medium. The growth and microscopic characters on this medium are similar to those of the conidia on the same medium.

Microscopic examination. Individual acervuli vary in height from 0·11 mm. to 0·25 mm. and in breadth from 0·22 mm. to 1·15 mm. The setae are 75-192μ long and 3-5μ diameter; they occur in acervuli in one part of the culture, while in other parts of the same culture they are absent. The conidiophores are up to 60μ long and 3 to 5μ diameter, and the conidia 12-27 × 4-8μ, with a mean (50 spores) of 18 × 5·26μ. The perithecia and perithecial stromata occur in the film of hyphae on the stroma of the culture medium, on the film, and on the stromata of the culture medium. Where a crack occurs in the culture medium, hyphae enter and form a network and in this network perithecia are formed. A peculiarity noticeable is that asci are not developed in perithecia except in the perithecia and loculi of the pulvinate masses found on the stroma of the culture medium. The asci are 40-70μ × 9-12μ; when viewed in mass they have a yellowish tinge. The ascospores are 14-21 × 5-7μ, with a mean (50 spores) of 17·54 × 5·6μ. When asci from the pulvinate masses are teased out and examined, ascospores are found budding off fusoid conidia while still inside the ascus (Plate XIV, figs. 8, 9.).

The results of an examination of a typical pulvinate mass composed of perithecia, and of perithecia found in different parts of the medium are here given.—

(A) *Pulvinate mass.* On the stroma formed in the culture medium (Plate XV, fig. 5). Greatest height 1·64 mm.; greatest width 1·38 mm. containing numerous perithecia and loculi in which asci are formed. The whole body is covered by the loose hyphae which grow as a film on

the stroma of the medium. With growth, the film is elevated. Dimensions and shape of a few perithecia in the mass are :—

(*a*) Spherical, diameter 125μ, wall 17μ thick.
(*b*) Spherical, diameter 52μ, wall 7μ thick.
(*c*) Spherical, diameter 70μ, wall 9μ thick.
(*d*) Spherical, diameter 135μ, wall 20μ thick.
(*e*) Globose, height 140μ, width 157μ, wall 15μ thick.
(*f*) Globose, height 175μ, width 190μ, wall 18μ thick.
(*g*) Vertically oval, height 135μ, width 70μ, wall 12μ thick.

(B) *Perithecia in the film of hyphae on the stroma of the culture medium.* These are usually spherical or globose and occur singly or fused together :—

(*a*) Spherical, diameter 158μ, wall 30μ thick.
(*b*) Spherical, diameter 70μ, wall 15μ thick.
(*c*) Spherical, diameter 142μ, wall 20μ thick.
(*d*) Globose, height 87μ, width 120μ, wall 18μ thick.
(*e*) Conoid, height 140μ, width 115μ, wall 15μ thick, thin near the apex.

(C) *Perithecia on the stroma of the culture medium* :—

(*a*) Globose, height 140μ, width 175μ, wall 12μ thick.
(*b*) Almost spherical, diameter 160μ, wall 15μ thick.

(D) *Perithecia in a crack in the culture medium* :—

(*a*) Globose, width 245μ, height 175μ, wall 30μ thick.
(*b*) Spherical, diameter 100μ, wall 18μ thick.
(*c*) Almost spherical, diameter 175μ, wall 17μ thick.

Maize-meal agar. The growth on this medium is identical with that of a single conidium on the same medium.

Microscopic examination. A single acervulus may have a diameter up to about 0·46 mm. The setae are up to 250μ long and 4μ diameter ; about 5μ diameter at the base. They vary in number in different acervuli, being few in some and many in others. The conidiophores are 3-5μ diameter and up to 40μ long. Very often in old cultures, the lower cells of the conidiophores are tinged light-brown. The conidia measure 12-20 × 5-7μ, with a mean (50 spores) of 16 × 5·7μ. When individual pustules were examined, conidia light-brown in colour were found in the mass which had germinated and possessed germ-tubes also light-brown in colour. The perithecia are usually spherical, globose, conoid or oval, varying in length up to 210μ and in width up to 122μ. The thickness of the walls in the different perithecia varies from 15-30μ. Spherical and globose bodies were found embedded in the culture medium.

These resembled perithecia, but contained no asci. Instead of asci a loose hyphal growth was present. These bodies occur singly or many may be fused together. The asci are 38-62 × 8-12μ and the ascospores 14-22×5-8μ, with a mean (50 spores) of 17×6μ. Ascospores tinged brown were found having a septum, occasionally two septa, rarely three.

Comparison of the behaviour of conidia and ascospores in culture

The conidia germinate in water in about four to seven hours and in about twenty-four hours a large number produce appressoria.

In Raulin neutral medium and maize-meal agar both the conidial and the perithecial stages are obtained. In the latter medium old acervuli were found producing perithecia.

In Raulin neutral medium the conidia measure 14-21 × 4-7μ, with a mean (50 spores) of 17·1 × 5·5μ ; the conidiophores up to 50μ long and 3-5μ diameter ; setae up to 210μ long and 5μ diameter ; asci 42-55 × 8-13μ ; ascospores 13-23 × 4-8μ with a mean (50 spores) of 17·3 × 5·8μ.

In maize-meal agar the conidia measure 12-21 × 4-7μ, with a mean (50 spores) of 16·5 × 5·3μ ; the conidiophores up to 52μ long and 4μ diameter ; setae up to 200μ long and up to 6μ diameter ; asci 38-60 × 7-11μ ; ascospores 14-20 × 5-7μ with a mean (50 spores) of 17·1 × 5·84μ.

The ascospores germinate in water in about the same time as the conidia and in about eighteen hours some germ-tubes terminate growth in appressoria. In cultures forty-eight hours old, germinated ascospores were found producing conidia, similar to those found in nature, at the end of branched germ-tubes.

In Raulin neutral medium and maize-meal agar both the conidial and the perithecial stages are produced. The mode of growth in both these media is similar to that of a single conidium in the coresponding medium.

In Raulin neutral medium the conidia measure 12-27 × 4-8μ, with a mean (50 spores) of 18 × 5·26μ ; the conidiophores up to 60μ long and 3-5μ diameter ; setae up to 192μ long and up to 5μ diameter ; asci 40-70 × 9-12μ ; ascospores 14-21 × 5-7μ, with a mean (50 spores) of 17.54 × 5·6μ.

In maize-meal agar the conidia measure 12-20 × 5-7μ, with a mean (50 spores) of 16 × 5·7μ ; the conidiophores up to 40μ long and 3-5μ diameter ; setae up to 250μ long and up to 5μ diameter ; asci 38-62 × 8-12μ ; ascospores 14-22 × 5-8μ with a mean (50 spores) of 17 × 6μ.

Conclusion

A single conidium from a chilli fruit in nature when taken into culture produces both a conidial and perithecial stage. A single ascospore from a chilli fruit in nature when taken into culture also produces a conidial and perithecial stage. The conidia, conidiophores, asci, and ascospores of both fungi are practically of the same dimensions. The modes of growth of both fungi on the two culture media are very similar. A germinated ascospore was found producing typical conidia. The dimensions of the conidia and ascospores in culture are similar to those found in nature. Under these circumstances, it is clear that the perithecial stage found in nature is the perfect stage of the *Colletotrichum*.

The *Colletotrichum* is no doubt *Colletotrichum nigrum* E. and Halst. and the perithecial stage *Glomerella piperata* (Stonem.) S. and v. S.

Inoculations

From conidia.

Experiment 1. On chilli fruits in the open. Seven ripe and three green fruits on plants in pots were inoculated by placing small pieces of the culture medium containing mycelium on the surface of the fruits. The pots were exposed in the open in the pot-culture house to sun and rain. On the following day as the inoculum appeared somewhat dry it was moistened with a few drops of distilled water. Mites were noticed running over some of the inocula. Six days after inoculation fructifications were produced all over the surface of one ripe fruit ; and on the following day this fruit had fallen and was shrivelled. It was placed in a sterile petri-dish, and, seven days later, the fructifications were prominent, in distinct longitudinal rows, both perithecia and acervuli being present. Seven days after inoculation, three other ripe fruits and one green fruit, which had begun to ripen showed signs of successful infection. On one, the whole surface on one side of the fruit was covered with fructifications, acervuli being present in abundance with perithecia sparsely scattered. The other three fruits had fructifications only around the inoculated spot, and these consisted of acervuli only. These latter fruits were picked and placed in sterile petri-dishes, and a fortnight later, they were sodden, with masses of black fructifications, which occasionally formed a crusted mass ; in these masses perithecia were found. In all cases where the fruits took infection the fruit stalks were also involved, fructifications being formed on them later.

When infection begins, the inoculated spot turns a dirty-brown colour, which continues to spread, and the black fructifications develop on its surface. Very often fructifications are formed on the apparently healthy green portion. When a fruit which bears fructifications is

opened, it is found that the seeds are covered with a weft of greyish hyphae, and masses of hyaline, thin hyphae are present inside the tissue of the seed. Very often the hyphae form sclerotium-like masses outside and inside the seed, and on the inner surface of the skin of the fruit.

Five inoculations failed to take, probably because the inoculum dried up before the hyphae had penetrated the fruit, or because it was disintegrated by mites. Fruits on plants in pots which were placed as a control by the side of the pot containing the inoculated fruits did not develop any disease.

Experiment 2. On chilli fruits in Roux tubes. Two fruits, one ripe and one green, but full grown, were washed in distilled water, placed in sterile Roux tubes and inoculated with a piece of the culture medium from a pure culture. After three days a slight discolouration was seen round the inoculated spot of the green fruit; this discolouration spread very slowly; in twenty-two days acervuli were produced and in about one month perithecia appeared. In the ripe fruit no external discolouration was seen, but small black bodies appeared over the surface near the stalk end in about three weeks; five days later these had increased in number and were developing towards the lower end of the fruit, while loose white hyphae were sparingly scattered all over the surface. The black bodies were masses of perithecia fused together. On opening the fruit the seeds were seen to be enveloped in a greyish white mycelium.

Experiment 3. On chilli fruits sterilised by boiling in Roux tubes. In a week's time the whole fruit was one black mass consisting of perithecia fused together. Three fruits were inoculated from a pure culture and all were successful.

Experiment 4. On sterilised potato slab. A potato was cut into slabs which were placed in Roux tubes, with a piece of cotton at the base, sterilised in an autoclave and inoculated with a piece of the culture medium. In three weeks' time the whole slab was a black mass, consisting of separate perithecia and perithecia aggregated together forming a crust. Perithecia had also developed in the cotton wool at the base. Two inoculations were made in two different tubes and both behaved alike, except that, in one, a few scattered acervuli were present.

From ascospores.

Experiment 1. On chilli fruits in the open. Five inoculations were made on fruits in the open, in a manner similar to that employed for the inoculations with the cultures from conidia. Two fruits were inoculated after wounding with pin-pricks and three without wounding. In five days' time the wounded inoculations showed signs of infection

and in thirteen days perithecia and acervuli developed. The unwounded inoculations failed to take.

Experiment 2. On chilli fruits sterilised by boiling in Roux tubes. Green fruits were boiled in water, placed in Roux tubes, and inoculated by placing a small piece of the culture medium containing hyphae on the surface of the fruits. In the following day white hyphae had grown luxuriantly from the inoculum and had spread over the surface of the fruits. Five days later, the whole fruit was enveloped in a mass of small black bodies and pink pustules of spores intermingled with loose hyaline hyphae. One fruit had no pink pustules, but the fructifications appeared on one side of the fruit in the form of a black crust. No setae were present in the pink pustules of spores, but when these spores were transferred to maize-meal agar slants, acervuli with setae developed. Four inoculations were made in four different tubes and all behaved alike. Two tubes kept as a control did not develop any fungus.

Experiment 3. On sterilised potato slab. The slabs were put into Roux tubes with cotton wool at the base and inoculated with a piece of the culture medium. Three days later white hyphae spread from the point of inoculation, over the surface of the slabs. In six days, from inoculation, the whole of one side of the slab was covered with perithecia, which also occurred on the cotton wool. When the culture was twenty-two days old, the whole slab was covered with perithecia. On one side of the slab, the mycelium grew as a compact film with perithecia embedded in it. All the asci were stalked similar to those grown on Raulin and maize-meal agar. This substratum appears to be very favourable for the abundant production of perithecia.

Eight inoculations were made on ripe fruits with pure cultures from conidia and five were successful ; four were made on green fruits and two were successful. In all twelve inoculations were made and seven took effect producing both stages of the fungus. On chilli fruits sterilised by boiling in Roux tubes and on sterilised potato slab the perithecial stage was obtained.

Three inoculations were made on fruit with pure cultures from ascospores and all failed to take effect ; two were made after wounding with pin-pricks and both succeeded, producing both stages of the fungus. On chilli fruits sterilised by boiling in Roux tubes both stages were produced, but on sterilised potato slab only perithecia were formed.

COLLETOTRICHUM NIGRUM E. AND HALST. NON-PERITHECIAL STRAIN

Diseased chilli fruits were found which bore fructifications of a *Colletotrichum* but not associated with a perithecial stage. The symp-

toms of the disease and its microscopic characters were similar to those of the perithecial strain. The acervuli were up to 0·55 mm. diameter; the setae up to 120μ long, 3-5μ diameter in the middle, and a little broader at the base; the conidiophores 2-4μ diameter and 12-40μ long. The conidia measured 12-23 × 4-6μ, with a mean (50 spores) of 17 × 4·5μ.

The conidia germinate in water in about the same time and in a similar fashion to the conidia from the perithecial strain. Single-spore cultures were readily obtained and grown on maize-meal agar. The mode of growth on this medium was similar to that of the perithecial strain. The setae were up to 200μ long and up to 5μ diameter; the conidiophores up to 38μ long and 3μ diameter; the conidia 12-21 × 4-6μ with a mean (50 spores) of 16·3 × 4·7μ. No perithecia developed in the culture medium, but instead there were small black bodies usually spherical or globose embedded in it, scattered or clustered having distinct dark brown walls. A few examples of these bodies are cited to illustrate their peculiar characters.

(A) *Embedded in the stroma of the culture medium.*

(*a*) Spherical, internal diameter 175μ, wall 35μ thick; hyphae inside the wall, loose, hyaline and light-brown.

(*b*) Nearly spherical, internal diameter 185μ, wall 28μ thick; internal hyphae faintly brown and hyaline.

(B) *On the stroma of the culture medium.*

(*a*) Globose, partly embedded, diameter about 210μ, wall 25μ thick; within, light-brown hyphae radiate from one side and grow out to the exterior forming a mass of aggregated brown mycelium on which conidiophores are produced.

(*b*) Irregular in shape, greatest width 0·82 mm.; greatest height 0.56 mm.; wall about 17μ thick; within the hyphae are hyaline, light-brown and loose and continue their growth to the outside, through one side of the wall at the top, forming a mass of brown pseudoparenchymatous tissue from which setae and conidiophores radiate in the shape of an open fan.

The fungus was also grown on French bean agar and on this medium also perithecia did not develop. Similar black bodies as formed on maize-meal agar were produced. The mode of growth of the hyphae was somewhat similar except that it was more fluffy. The conidiophores attained a length of 60μ and the conidia measured 12-21 × 4-6μ with a mean (50 spores) of 16·62 × 5μ.

Seventeen inoculations were made on chilli fruits and twelve were successful; five inoculations were made after wounding and all were suc-

cessful. No perithecial stage was formed. On chilli fruits in Roux tubes sterilised by dipping in boiling water and on sterilised potato slab, the perithecial stage was not produced.

This fungus is no doubt *Colletotrichum nigrum* E. and Halst., but it does not produce a perithecial stage in nature, in culture or on inoculated chilli fruits. The small black bodies which are formed in the culture media and which possess walls appear to be attempts on the part of the fungus to produce perithecia.

GLOEOSPORIUM PIPERATUM E. AND E.

A *Gloeosporium* was found attacking ripe chilli fruits in the field. The disease usually appears on the fruit as minute black or yellowish sunken spots which gradually extend, turning the skin a dirty-brown colour. The symptoms and microscopic characters of the disease are practically identical with those of *Colletotrichum nigrum*, except that the acervuli of the *Gloeosporium* are devoid of setae. Cream-coloured and pale-pink pustules of spores develop freely on the diseased tissue ; full-grown fruits still green, are also subject to attack. The affected area turns dirty-brown and becomes sunken and fructifications in the form of small black points spread round the sunken spot very often in concentric zones. The conidiophores are up to 27μ long and 2-3μ diameter ; the conidia 11-24 × 4-6μ with a mean (50 spores) of 15·76 × 4·7μ. No perithecial stage was associated with the fungus.

The conidia germinate in water in about five hours and the germ-tubes frequently anastomose. A conidium may produce a germ-tube which is capable of producing another conidium and this conidium could produce another germ-tube which in turn can give rise to another conidium and so on. The germ-tubes do not form appressoria. In standard nutrient solution the spore behaves in a similar manner.

Single spore cultures were obtained and transferred to maize-meal agar slants. The mode of growth was similar to that of *Colletotrichum nigrum*. The conidiophores were up to 50μ long and 2-3·5μ diameter ; the conidia 11-20 × 4-6μ with a mean (50 spores) of 15 × 4·6μ. No setae developed in culture and perithecia were not produced, but instead small black bodies with distinct dark-brown walls similar to those found in the non-perithecial strain of *Colletotrichum nigrum* were present, having practically identical characteristics. When the fungus was grown on Raulin neutral agar and French bean agar, the behaviour was similar to that on maize.

Fourteen inoculations were made on green fruits and eleven were successful ; four inoculations on ripe fruits and three were successful.

No perithecial stage was obtained. On chilli fruits sterilised by boiling in Roux tubes and on sterilised potato slab no perfect stage developed.

Comparing the dimensions of the spores with that given for *Gloeosporium piperatum*, the two fungi are apparently the same. The perfect stage of *Gloeosporium piperatum* is said to be *Glomerella piperata* (Stonem.) S. and v. S., but it was not found in nature on chilli fruits in Peradeniya, nor could it be obtained in culture. The small black bodies found in culture appear to be attempts at perithecial formation.

VERMICULARIA CAPSICI SYD.

The first symptom of the disease is a slight depression dirty-brown in colour on the surface of the fruit. This dirty-brown colour gradually extends generally longitudinally along the fruit towards the lower end. The affected area turns dry and black fruiting bodies soon appear on the dry area, either irregularly or in concentric zones. With the formation of fructifications the skin shrivels and becomes wrinkled. Spores ooze out from the black bodies in pale pink pustules. With the aid of a hand lens, black, bristly hairs are visible in the fruiting masses. The fruit stalk too gets affected and gradually the fungus enters the branches and kills them back. Diseased fruits are frequently seen hanging on the bush for a considerable time, but sometimes they drop to the ground.

The fungus is a *Vermicularia*. The tubercular stromatic masses measure 70-140μ diameter. From the surface of the tubercular masses, closely crowded hyaline stalks arise appearing yellowish in mass. These are the condiophores which are non-septate and unbranched and are usually of the same length as the spores they bear, varying in length from 12-27μ and in diameter from 2-4μ. The setae are dark-brown, stiff, rigid, erect, septate, acute and paler at the apex, up to 210μ long and 4-6μ diameter. The conidia are pinkish in mass, hyaline, non-septate, curved, narrowed at the ends, 15-28 × 2·5-4μ with a mean (50 spores) of 23·3 × 3·5μ.

On the inner surface of the skin of the fruit small, black, round, pseudoparenchymatous bodies are found. Some bodies are bounded by a layer of dark-brown, thick-walled cells forming a wall about 12-17μ thick in different bodies, while the central cells are loose, hyaline or faintly brown. These bodies are almost spherical in shape and vary in diameter from 70-140μ.

The fungus also attacks the seeds. The hyphae inside the seed are hyaline and turn brown when they collect into masses.

Cultures

Single spore cultures were made from conidia ; they were germinated in water and also grown on maize-meal agar and French-bean agar to see whether the perfect stage would develop in culture.

Germination in water. A series of drop cultures was made in ordinary tap water and examined from time to time. In a culture five hours old few spores had germinated, sending out short, hyaline germ-tubes from near the ends up to 25μ in length and 1·5-2μ diameter. Nearly all the germinated spores had a spherical swelling, hyaline and thin-walled at the end of the germ-tubes. These terminal swellings are immature appressoria. Some germinated spores had become bicellular by a septum being formed near the middle of the spore. In a culture seventeen hours old practically all the spores had germinated and were bearing appressoria at the end of short germ-tubes. A germ-tube rarely reaches a length of 60-80μ before the appressorium is formed. The appressoria which were hyaline and thin-walled at first are now thick-walled and dark-brown, spherical, oblong-oval or globose, varying in diameter up to 5μ. An appressorium may germinate and form another appressorium at the end of a short germ-tube. The majority of the germinated spores have a septum. In a culture twenty-four hours old, spores were found having very long germ-tubes and terminating growth in appressoria and these appressoria germinating again and continuing vegetative growth. Some spores were found having two germ-tubes, one at each end.

Maize-meal agar. The slants were inoculated with spores from a pure culture. On the third day white floccose hyphae had grown one centimetre from the point of inoculation on the surface of the medium. On the following day small raised black bodies appeared on the surface and a few were embedded in the culture medium. At the sides, where the culture medium meets the glass, very small black bodies were found. By the seventh day growth had extended to three centimetres and was aerial, woolly, and greyish-white in mass. A large number of the black bodies found in the medium were producing spores, pale-buff in mass. Aerial growth now ceases altogether and the fungus confines itself to the medium. In old cultures, a distinct margin is formed, of black stromatic tissue at the sides. In some old cultures instead of the fructifications appearing as buff-coloured pustules, they appear as rough, black, bristly heads.

Microscopic examination. The hyphae which appear greyish-white in mass are loose and hyaline. Hyphae 6-8μ diameter had branches 2-3μ diameter and spores were produced at the end of these branches.

In microtome sections a pseudoparenchymatous stroma consisting of closely interlaced brown mycelium is found in the culture medium

up to about 0.92 mm. deep. The black bodies producing spores are stromatic masses, made up of closely interlaced brown mycelium. They are of various shapes, being usually pulvinate, cup-shaped or spherical and with a diameter up to about 0·56 mm. They occur singly or clustered together, and sometimes covered with a thin film of brown hyphae. The black bodies which did not produce spores and appear like sclerotia are simply masses of brown hyphae aggregated together. They are spherical or nearly spherical in shape, varying in diameter up to about 140μ and are found in the culture medium and in the pseudostroma formed in the medium. The black band at the sides of the culture medium is composed of stromatic tissue formed by hyphae producing appressoria which run into chains.

Setae and conidiophores arise from the surface of the stromatic masses. The former are dark-brown, rigid, septate, and slightly swollen at the base, paler at the apex and varying in length up to 280μ, and in diameter up to 6μ. The latter are similar to those found in nature. The conidia are hyaline, non-septate, curved, narrowed at the ends, and measure 15-30 × 3-4μ with a mean (50 spores) of 22·5 × 3·6μ.

French-bean agar. The slants were inoculated with spores from a pure culture. On the third day white floccose hyphae had grown about eight millimetres distant from the point of inoculation. From the fifth day onwards hyphae grow confined to the surface of the medium and fructifications buff colour and black in mass begin to be formed. After the seventh day no hyphal growth is visible on the surface of the culture medium and fructifications increase in number. At the edges when the medium meets the glass a black band of stromatic tissue is formed. In old cultures the surface of the medium is covered with black fructifications in the form of bristly heads.

Microscopic examination. The loose floccose hyphae very frequently produce spores at the ends of their branches. Certain cells of the hyphae swell out, gradually turn brown and are capable of giving out a hyaline hypha. These are intercalary chlamydospores. The black band of stromatic tissue at the edges of the culture medium is composed of chains of appressoria.

In microtome sections a pseudoparenchymatous stroma varying in depth up to about 1·38 mm. made up of interlaced brown and hyaline hyphae is found in the culture medium. Spores are produced from stromatic masses. These masses are of various shapes being usually cup-shaped, pulvinate or tubercular occurring singly or aggregated and varying in diameter up to about 0·78 mm. The outer portion of these masses is composed of darker-brown cells and it is from these cells that setae and conidiophores arise. The cells within the tubercle are hyaline

and faintly-yellowish in colour. Small black bodies, spherical or globose in shape, are found in the film of mycelium on the culture medium, on the stroma in the medium or attached to stromatic masses producing spores. They are composed more or less uniformly of brown cells, and vary in diameter up to 280μ. In some bodies a wall about 15μ thick is found consisting of darker-coloured cells. Within the wall the hyphae are hyaline or faintly-brown. The setae and conidiophores arise from the surface of the stromatic masses. The former vary in length up to 380μ and in diameter at the base up to 8μ. The conidiophores are of the same dimensions as in nature. The conidia measure 20-32 × 2·5-4μ, with a mean (50 spores) of 26·5 × 3·5μ.

The *Vermicularia* found on chilli is *Vermicularia Capsici* Syd., but no perfect stage is found in nature or in culture.

Inoculations

Experiment 1. On chilli fruits in the field. Five inoculations were made on four green and one ripe fruit by placing small pieces of a pure culture on maize-meal agar on the surface of the fruits, covering the inoculum with a piece of sterilised cotton wool and wetting the whole with distilled water. The cotton wool was wetted daily. On the sixth day a slight discolouration was visible round the inoculated spots of three fruits. The cotton wool was removed and the fruits exposed. On the tenth day fructifications developed. After a fortnight these fruits were plucked and examined. The skin over the affected area was quite dry and leathery, not sodden. The seeds were enveloped in a greyish mycelium. Two of these fruits were left in a sterile petri-dish for over a month and examined from time to time, but no perfect stage was found. Two green fruits failed to take infection. Three fruits were left as a control on the same bush, a small piece of cotton wool being placed on them and wetted daily for six days, but no disease developed in them.

Three inoculations were tried on green fruits after wounding and these developed the disease within four days.

Experiment 2. On chilli fruits in sterile test-tubes. Three green and one ripe fruit was washed in ·1 per cent. Corrosive Sublimate for ten minutes, then in distilled water, put into sterile test-tubes and inoculated with spores from a pure culture. After six days one green fruit began to discolour turning dirty-green at the lower end of the fruit, although the inoculum was placed near the stalk end of the fruit, which spot was yet not discoloured. This may have been due to the spores running down the fruit to the bottom, mixing with the little water that was present at the lower end of the test-tube and infecting the fruit from there

Five days later black fructifications were found in abundance at the lower end of the fruit and gradually extended upwards. The three other fruits began to discolour at the inoculated spot on the fifth day and ten days later black fruiting bodies began to appear round the inoculated area. No aerial hyphae were found. Two fruits which were kept as a control in sterile test-tubes remained unaffected during the period of the experiment.

Experiment 3. On chilli fruits in a moist chamber. (*a*) Four green and two ripe fruits were sterilised as in Experiment 2, placed in a moist chamber and inoculated with spores. The spores were mixed in sterile water and two drops were placed on each fruit. Four days later three green and one ripe fruit turned pale in colour and soft to the touch. On the eighth day white fluffy hyphae overran the surface and on the eleventh day fructifications began to be formed plentifully. On the other green fruits discolouration appeared on the sixth day and fructifications developed on the eleventh day ; no external hyphae were found and the fruit did not become soft. The other ripe fruit did not develop the disease. One ripe and one green fruit were kept as a control in the same moist chamber, but remained unaffected during the experiment. (*b*) Two green and two ripe fruits were inoculated in a similar manner to the above, but after wounding with pin-pricks. Infection took readily, discolouration was visible in three days and in six to eight days fructifications developed. The fruits became quite sodden and spores appeared in dirty white and cream-coloured pustules.

Experiment 4. On chilli fruits sterilised by dipping in boiling water. Four green fruits were sterilised, put into Roux tubes and inoculated with spores. On the fifth day the surface of the fruits was covered with black fructifications. Aerial growth of white hyphae was present, but was hardly noticeable.

Experiment 5. On sterilised potato slab. The fungus grew profusely on the potato slab and produced a copious mass of white hyphae on the surface. When examined two months later the hyphae had disappeared and a black stroma was found on the surface and abundant masses of sclerotium-like bodies were formed in this stroma. These masses were made up of hyphae, brown in colour, closely aggregated together. No spores were produced.

Eleven inoculations were made on green fruits and nine were sucessful ; four on ripe fruits and three were successful. Five inoculations were made on green fruits and two on ripe fruits after wounding, and all were successful. No perfect stage was found.

On sterilised potato slab and on sterilised chilli fruits no perithecia developed.

SUMMARY

1. Three fungi are found on chilli fruits in nature in Ceylon,—a *Vermicularia*, a *Colletotrichum* and a *Gloeosporium*, and they have been identified as *Vermicularia Capsici*, *Colletotrichum nigrum* and *Gloeosporium piperatum*.

2. Two strains of *Colletotrichum* occur—one, a perithecial strain and the other a non-perithecial strain; the perfect stage of the perithecial strain is identified as *Glomerella piperata*.

3. The perfect stage of *Gloeosporium piperatum* was not found in nature on the fruit, nor could it be obtained in culture. In the United States it has been identified as *Glomerella piperata*. At Pusa, India, it is found on the plant and in culture.

4. If it is established that the perfect stage of *Gloeosporium piperatum* is *Glomerella piperata*, then the Ceylon *Gloeosporium* which has not been found to produce perithecia and the Ceylon *Colletotrichum* which produces a perithecial stage, are both the same fungus. But the cultures described in this paper do not provide any evidence on that point.

5. The formation of setae of *Colletotrichum nigrum* in culture is not a constant feature. They may occur in acervuli in one part of the culture medium whereas in other parts of the same culture medium they are absent.

6. It is of interest to note that a large number of conidia of both the strains of *Colletotrichum nigrum* produce appressoria at the end of germ-tubes when sown in water, but the conidia of *Gloeosporium piperatum* do not form appressoria.

7. The perfect stage of *Vermicularia Capsici* has not been found.

To Mr. T. Petch, the late Mycologist and Botanist, I have to express my thanks for helpful criticism and advice.

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EXPLANATION OF PLATES

Plate XIV

Figs. 1, 2, 3. Conidia germinating in water and forming appressoria. × 950.

Fig. 4. Conidium producing an intercalary chlamydospore. × 950.

Figs. 5, 6, 7. Asci. × 950.

Figs. 8, 9. Ascospores budding off secondary conidia. × 950.

Fig. 10. Ascospore germinating in water and forming conidia at the end of lateral branches. × 950.

Fig. 11. Ascospore germinating at both ends. × 950.

Figs. 12, 13, 14. Ascospores germinating in water and forming appressoria. × 950.

Fig. 15. Ascospore in water, producing a germ-tube at one end and budding off a secondary conidium at the other end. × 950.

Plate XV

Fig. 1. Vertical section of a globose perithecium with conical apex. × 270.

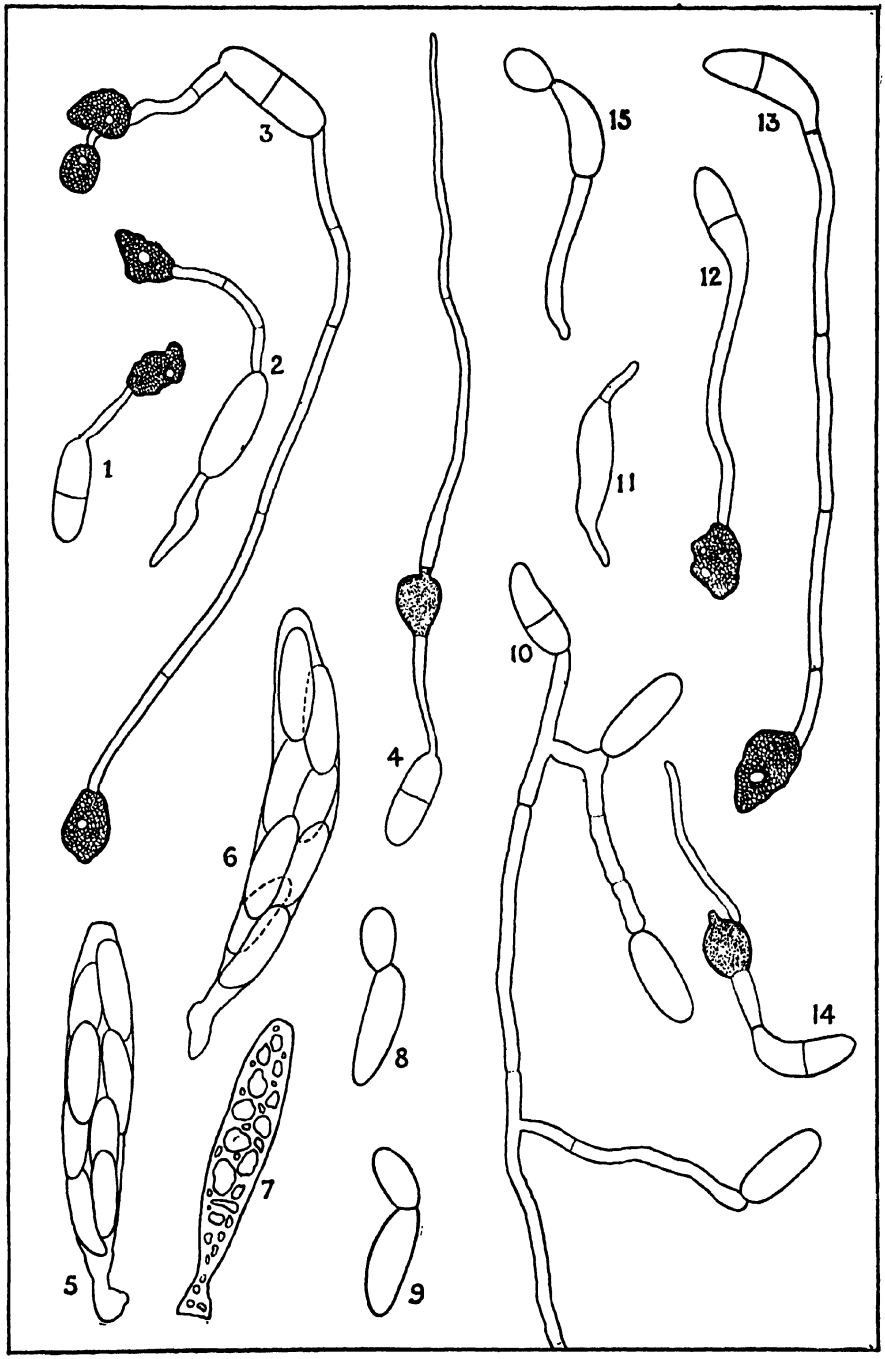
Fig. 2. Vertical section of a flask-shaped perithecium fused with another perithecium. × 230.

Fig. 3. Vertical section of two conoid perithecia × 228.

Fig. 4. Vertical section of a conoid perithecium attached to an acervulus. × 235.

Fig. 5. Vertical section of a pulvinate mass, composed of numerous perithecia and loculi formed in culture. × 26. Original culture from a single ascospore.

Fig. 6. Vertical section of a normal acervulus producing perithecia in culture. × 52. Original culture from a single conidium.



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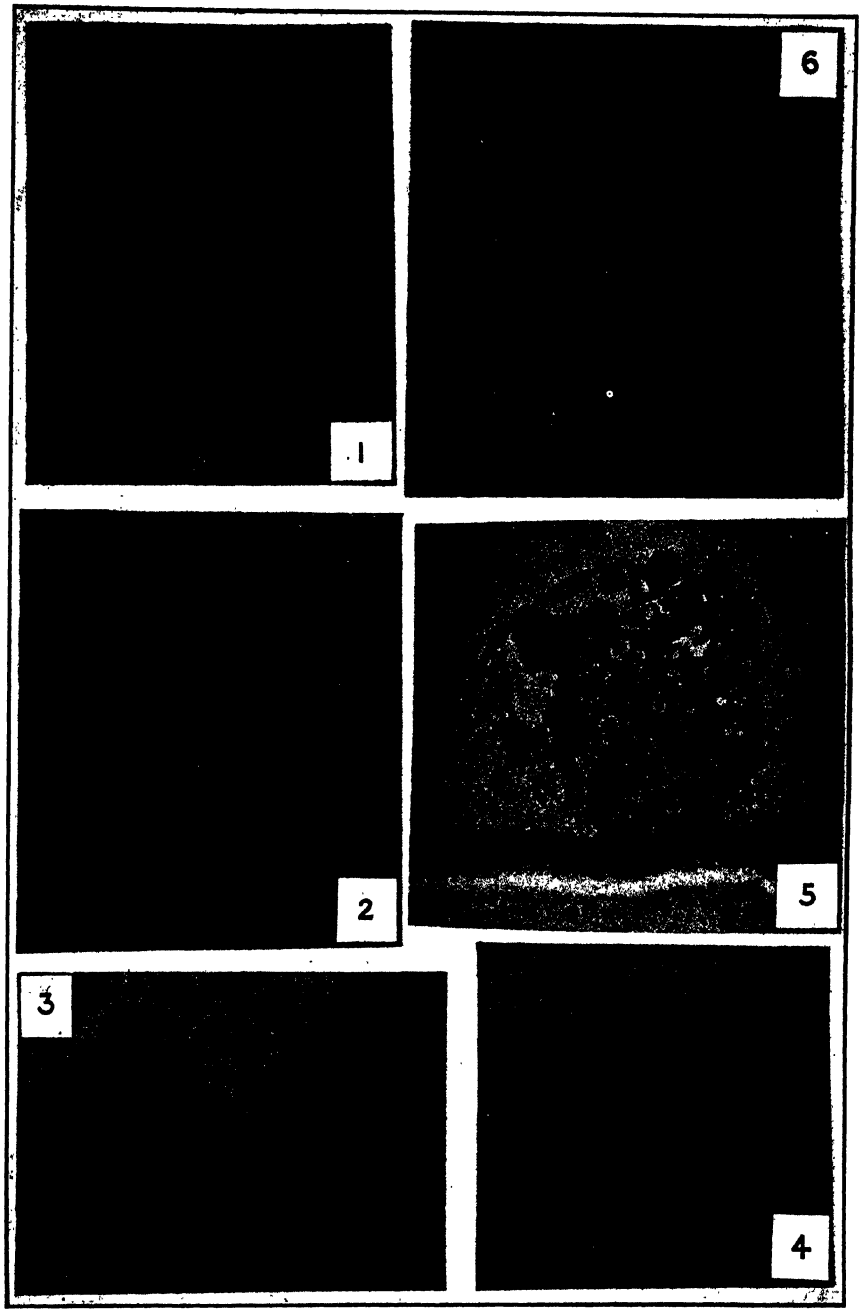

Bertus—Diseases of Chillies

Notes on some Symplocaceae of Ceylon

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Brand (2) who treats the species of *Symplocos* as a separate order, includes *S. versicolor* Clarke under *S. spicata* Roxb., stating (p. 40) " Haec species valde variabilis a cl. A. DC., Clarke aliisque in multas varietates divisa est. Sed. inter has varietates tam multae formae intermediae occurrunt, ut melius esse videatur varietates bene circumscriptas non constituere." In the course of his description of *S. spicata* Roxb., drawn up from the several specimens examined by him, he says (I) " folia serrata vel subintegra, utrinque acuta " (II) " Fructus c. 5 mm. longus." He makes a new var. β *acuminata*—" Folia longe acuminata," and on pp. 32 and 33 in his key, he credits *S. spicata* with " Inflorescentiae semper vel partim compositae."

Now *S. versicolor* Clarke has (I) entire very faintly crenate margins, (II) Fruit 1.3 cm. long, (III) a caudate-acuminate leaf which does not resemble that of *S. spicata* var *acuminata* Brand., (IV) a simple inflorescence (compare Trimen's key (1) p. 103). The other points of difference are tabulated below.—

	S. versicolor	*S. spicata*
1.	Petiole thin and slender.	Petiole stout.
2.	Flowers few on each inflorescence.	Flowers numerous on each inflorescence.
3.	Inflorescence 2·5-3·8 cm. long.	Inflorescence 5·1-7·6 cm. long.
4.	Calyx segments ciliated.	Calyx segments not ciliated.
5.	Drupe linear-oblong, 1·3 cm.	Drupe urceolate, short, 0·5 cm.
6.	Seed and embryo straight.	Seed and embryo curved.

In view of these ten points of difference *S. versicolor* Clarke should be maintained as a distinct species.

Symplocos obtusa var. **obovata** Thw.

Trimen (1) p. 105 made the following note on this variety: "var. . looks very different, and is perhaps distinct as a species." Brand had not seen specimens of this plant, which has indistinctly pentadelphous stamens, filiform filaments, a trilocular ovary with a glabrous style, seeds and embryo straight. According to the various keys given by Brand (2), based on the 281 species he examined, this specimen comes under subgenus *Hopea* (L.f.) Clarke, Section *Bobea*, subsect. *Lodhra*, which includes one hundred and twenty-two species. *S. furcata* Brand (*S. obtusa* Thw.) is the 44th of this group and *S. obtusa* var. *obovata* works down to between the 92nd *S. buxifolia* Stapf, and the 93rd, *S. anamallayana* Bedd. from both of which it differs abundantly. Furthermore, Brand (2, p. 57) describes *S. furcata* (*S. obtusa* Thw.) as having (I) " Folia 4-6 cm. longa, 2-3 cm. lata," (II) " Corolla 6-vel 7-partita," (III) " Fructus c.10 mm. longus ;" and (IV) In his keys, pp. 42-48, he attributes to *S. furcata* (*S. obtusa* Thw.) an inflorescence of 4-numerous flowers. *S. obtusa* var. *obovata* Thw. has (I) Leaves 2·5-3·5 cm. long, 2-2·5 cm. broad,(II) Corolla 5-partite,(III) Fruit 1·3 cm. long,(IV)Solitary and axillary flowers. The other points of difference are shewn in the following table.—

	S. furcata (*S. obtusa* Thw.)	*S. obtusa* var. *obovata*.
1.	Leaves oval or obovate-oblong.	Leaves broadly obovate or sub orbicular.
2.	Leaf apex obtuse or shortly acuminate.	Leaf apex obtuse or retuse.
3.	Leaf margins glandular denticulate, or serrate, faintly revolute.	Leaf margins entire, distinctly revolute.
4.	Flowers sessile except at the base of the inflorescence.	Flowers distinctly long-stalked.
5.	Flowers 1-1·25 cm. across.	Flowers 0·75 cm. across.
6.	Calyx segments round, ciliate.	Calyx segments triangular with acute apices.
7.	Corolla 6-7 segments.	Corolla 5-segments.
8.	Drupe oblong-ovoid.	Drupe narrow, cylindrical.

In view of all these differences this variety is entitled to specific rank.

S. obovata (Thw.) Wight and Gardner MSS. in Thw, Enum. Pl. Zeyl. (1860) p. 185. *S. obtusa* Wall var. *obovata* Thw., Enum., (1860) p. 185, Trimen, Fl. Ceylon, III (1895) p. 105 C.P. 1819.

Arbor glaber. Folia 2.5-3.5 cm. longa, 2-2.5 cm. lata, coriacea, glabra late obovata vel suborbicularia, apice obtusa vel retusa, basi cuneata integra, breviter petiolata. Flores solitarii in axillis foliorum summorum. Pedunculi petiolo 2-3-plo longiores; bracteae obovatae; calyx glaber, lobis triangularibus tubo brevioribus; stamina c. 40; ovarium glabrum. Fructus 1.3 cm. longus, oblongo-cylindricus, lobis discum superantibus.

Endemic. Upper Montane Zone; common. Pidurutalagala, Pallagalla. Flowers April.

S. eugenioides (Champ.)

Trimen (1) p. 109 says in a note on *S. minor* " I cannot distinguish var. *eugenioides* Champ. (Fl. B. Ind.), from var. *glabrescens*. The leaves are often cucullate. If we are to accept Brand (2, p. 64) who gives *S. glabrescens* specific rank, then, according to Trimen, *S. minor* var. *eugenioides* is the same as *S. glabrescens*. But according to Brand's definition, *S. glabrescens* has (1) Folia 3-4 cm. longa, 2-3. cm. lata, (2) Spicae pilosae 2-3 florae, (3) Spicae petiolo 2-3-plo longiores, (4) Stamina ultra 30, (5) Ovarium brevissime pilosum, (6) Fructus 12 mm. longus. *S. minor* var. *eugenioides* has (1) Leaves 4-6·5 cm. long, 3·2-4 cm. broad, (2) Spike villose 4-flowered, (3) Spike 1½ times longer than the petiole, (4) Stamens about 60, (5) Ovary glabrous, (6) Fruit 15 mm. long. *S. minor* var. *eugenioides* also differs in having entire leaf margins instead of serrated margins.

On the other hand, we find that *S. minor* differs from *S. minor* var. *eugenioides* in the points shewn in the following table :—

	S. minor	var. *eugenioides*
1.	Branches hirsute all over.	Branches very slightly pubescent with adpressed hairs only at the extreme apex.
2.	Leaves small, 3-4 cm. long, 2-2·5 cm. broad.	Leaves large 4-7·5 cm. long. 3·2-4 cm. broad.
3.	Leaves with many long bristles on the lower surface.	Leaves sparingly hairy on the midrib on the lower surface.
4.	Leaf margins denticulate serrate, revolute.	Leaf margins entire, not revolute.

5.	Petals nearly 0·5 cm.long, densely hirsute.	Petals 1 cm. long, glabrous.
6.	Racemes 2·5 cm. long.	Racemes 1·5 cm. long.
7.	Corolla 6 partite.	Corolla 5 partite.
8.	Fruit 10 mm. long.	Fruit 15 mm. long.

S. eugenioides is therefore entitled to specific rank.

S. eugenioides (Champ.) Livera sp. nov. *S. minor* Clarke var. *eugenioides* Champ. ex Clarke in Hook. f. Flora British India III (1882) 586.

Frutex initio villosus mox glaber. Folia coriacea 4-7·5 cm. longa, 3·2-4 cm. lata, elliptica, supra glabra, subtus breviuscule pilosa ad nervos, acuminata, subserrulata, basi rotundata. Spicae villosae 2-4 florae, petiolo 1·5-4 plo longiores, pilis brevibus densae vestitae; bracteae oblongo-lineares; calyx glaber, lobis rotundatis tubo subaequantibus vel longioribus; corolla calyce 2·5-3 plo. longior, 5-partita. Stamina circiter 60; ovarium glabrum. Fructus 1·5 mm. longus, nitidus, glaber, cylindricus, apice paullo angustatus.

Endemic. Horton Plains and Namunukulakanda.

The older part of the branches is quite glabrous. Leaves acute acuminate, shortly and distantly serrate: veins prominent. Inflorescence axillary, densely villous. Bracts and bracteoles subsimilar, densely villose on outer surface only. Flowers sessile; sepals oblong-obtuse, glabrous. Corolla 0·5 cm. long, petals obtuse, stamens indistinctly pentadelphous. Disc villous. Style glabrous.

Brand separates a new species *S. amabilis* (p. 63) from *S. elegans* Thw. His description of *S. amabilis* applies to Thwaites' type specimens of *S. elegans* with the exceptions (I) Folia crasse coriacea, (II) Pedunculi ferruginei petiolo brevissimo 3-4-plo longiores. With dried specimens one cannot with certainty say whether leaves are thinly or thickly coriaceous. There are peduncles of *S. elegans* which are even ten times longer than the petioles and these may include *S. amabilis*. The differences between *S. elegans* Thw. and *S. amabilis* as Brand gives them are tabulated below :—

	S. elegans.	*S. amabilis.*
1.	Ramulis hirsutis.	Splendide ferrugineis.
2.	Folia 5-6 cm. longa, 1·5-2·5 cm. lata.	3-5 cm. longa, 1·5-2·5 cm. lata.
3.	Stamina 60-80.	Ultra 30.
4.	Ovarium brevissime pilosum.	Glabrum.
5.	Inflorescentiae 4-numerosae florae.	1-3 florae.

1. In the harbarium specimens of *S. elegans*, all stages between " hirsutis " and " splendide ferrugineis are found."

2. All Thwaites' type specimens of *S. elegans* (with the exception of one, in fruit—which has leaves 6 cm. long) have leaves under 5 cm.; moreover, the difference between the maximum lengths of the leaves of the two species is only 1 cm. 3. Some type specimens of *S. elegans* have the number of stamens varying between 30 and 60 and inflorescences of less than four flowers. Therefore, the only difference between the two species is in the ovaries and this is a slight one. *S. amabilis* Brand cannot therefore be maintained as a distinct species.

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